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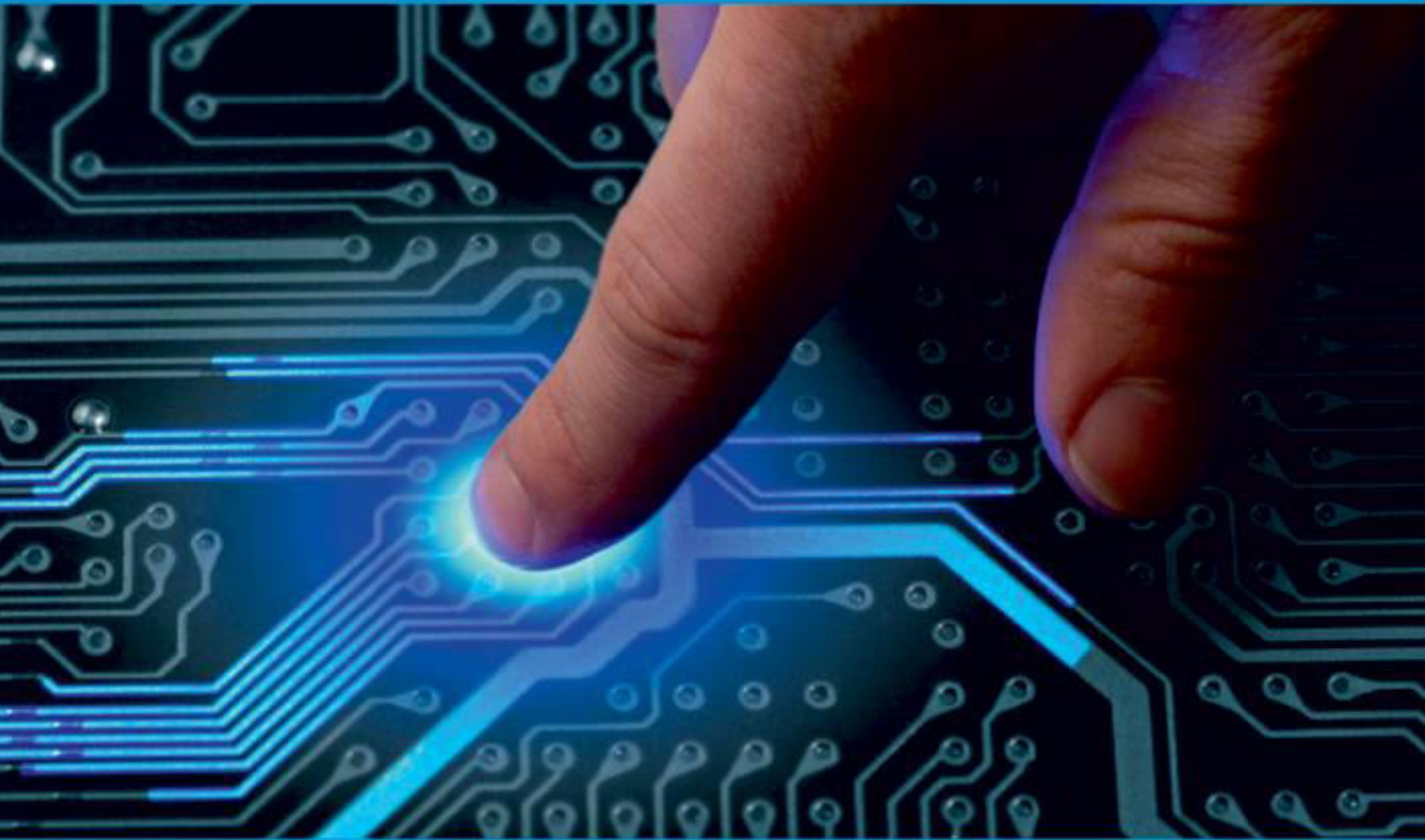

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Sleep-Awake and ACO based Resource Saving Protocol for WSN

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ABSTRACT: A significant and difficult problem in sensor networks is the efficient use of energy. As a result, various protocols have been developed with the primary goal of optimising network energy usage. The majority of the energy is used up when data packets are being routed. In this article, we've used the ant colony optimisation method based on swarm cognition to route data packets between sensor motes. A few sensor motes may also be put into sleep mode based on the quantity and location of sensor motes, which prolongs the network's longevity and saves resources. The lifetime of a sensor network can be improved by reducing its energy consumption during the routing process. Ant colony optimization method provides an optimal path for data delivery to the destination node. Energy consumption in routing can be reduced by selecting shortest path to the sink. Other than optimization, sleep scheduling among sensor nodes plays an important role in achieving efficient energy conservation and long lifetime. If the node density is large in an area, some nodes can periodically switch off their radio. When node density is high in the network, many nodes waste their energy by idle-listening or overhearing. In this work, we have used a threshold energy based, sleep-awake scheduling and ant colony optimization method (SA-ACO) to preserve the power in the network.

KEYWORDS: **WSN, ACO, Sleep-Awake Scheduling, Clustering**

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I. INTRODUCTION

he speedy evolution of wireless communications, micro-fabrication and electro mechanical MEMS technology has empowered the development of low power, low cost and tiny sensor nodes. These nodes are capable of gathering information, processing the information and communicating with other sensors through the wireless medium like radio frequency (RF) [1]. A wireless sensor network(WSN) is embodied of a large number of sensor nodes, which are closely deployed in a region of interest. The sensor network may stir up the process of observing physical and environmental circumstances, information collection and transmission of the processed information to the base station or the sink node. It is a very auspicious network, which can be used in various areas like, landslide detection, environment monitoring, military surveillance, target tracking, localization, health care, water quality and traffic monitoring [2-5].

A (WSN) is also called a sensor network or an actor network [6]. It is a distinctive class of ad-hoc networks, as it has a high density of sensor motes as compared to other types of ad-hoc networks. A WSN can have dissimilar types of topology like star, multi-hop wireless mesh network, tree, peer to peer and hybrid topology [7]. Nodes in the sensor network can change topology by using different power level for broadcasting. In a dense deployment, if a node broadcasts with less power, the energy of the sensor node is saved without affecting the working of a network. A network is homogeneous, if in the beginning, all the sensor nodes in the network have equal amount of energy and a network is heterogeneous if the initial amount of energy is not equal in different nodes. For example some percentage of sensors are equipped with battery having extra energy than the other sensors in the network. Let n be the number of the sensor nodes present in a network and f be the percentage of sensors which are furnished with y times extra energy. Out of n nodes, f nodes are chosen and these nodes with extra energy are known as advanced node and other nodes as the normal nodes [8].

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II. RELATED WORK

According to the study, data collection methods based on clustering are extremely beneficial in terms of energy conservation. In addition, cluster head (CH) optimisation is an NP-hard polynomials problem. By selecting the best route for routing, the network's longevity and energy consumption are both increased. The lifespan of the network is reduced when there is an energy hole [3] caused by the SNs dying too soon due to an imbalance in the interpersonal channel's information flow. Authors in [8] proposed an improved Cuckoo Search (CS) based energy balancing node clustering methodology employing a new objective function using an even allocation of CHs. For distributing the data packet through the CHs and the sink, authors in [9] used an improved Harmony Search (HS) based routing protocol. The practicality of the proposed combined clustering and routing protocol was assessed using the average consumption of electricity, the proportion of live and dead nodes, and the average duration of the network. The new integrated routing and clustering protocol based on CH Search explained better results when compared to state-of-the-art methods. When developing cutting-edge meta-heuristic protocols with incorporated routing and clustering, the author forgets to take into account the lifetime and end-to-end delay components. The goal of this research is to cluster SNs with optimal network lifetimes in order to take advantage of optimal covering.

Shanthi and Sundarambal [10] introduced a multi-hop clustering approach based on Fish Swarm Optimisation (FSO) to reduce WSN energy consumption. The outcome demonstrates that the suggested strategy outperforms the traditional models. As a result, Marhoon et al. [11] created an original algorithm to boost the LEACH protocol's effectiveness for achieving the clustering target. The LEACH methodology was then enhanced by Marhoon and Awaad [12] to lower the energy usage in WSNs. The literature researches, however, do not include the network lifetime maximisation under the restriction of effective packet delivery in a minimum end-to-end delay framework. We are thus driven to create an effective meta-heuristic method in order to address the gaps in the literature investigations.

III. PROPOSED METHOD

We have anticipated the sleep-awake scheduling strategy that helps in improving the lifetime of the network. For a short time, a sensor node can turn off its radio and enters into sleep state to preserve energy. However, if a sensor repeatedly changes its state awake to sleep and vice-versa, it can be malfunctioned and stop working, and therefore leads to energy holes in the network. To avoid this situation, certain percentage i.e. P1% of nodes are kept in sleep mode at any instance of time. The criterion to keep a node in the sleep mode is described below. If the energy of an active node falls below a threshold value, it goes to sleep state and another node from the sleep mode switch into an active mode. In this way, a node turns active only when it is necessary. Every sensor node in the network has the same transmission range for the communication. Initially, the sink node broadcast a HELLO packet, and sensor nodes respond with their location and energy information to the sink. In case of multi-hop routing, nodes transmit data to a nearby node. But in case no node is available nearby, it transmits data to the next nearest node. However, data can be transmitted only up to its maximum transmission range.

Initially, all the sensor nodes have enough energy to transmit data up to the maximum transmission range. Sink node calculates the energy required by a node for the given transmission range and transmits this information to other nodes. As the sink node is not an energy constrained node, energy consumed by the sink, in computation process does not affect the life span of the network. The amount of energy necessary for transmission is designated as the threshold energy (Thenergy). After some round of the communication in the network, the amount of energy in a sensor node changes according to its role and position in the network. If it is a cluster head node, it consumes more energy as compared to other nodes. If the residual energy of a node is greater than the threshold energy, it is in active mode and set for communication and data transmission, otherwise it turns into sleep mode. The percentage of nodes in sleep mode varies according to the density of nodes.

We have adopted a hierarchically clustered sensor network as described in LEACH protocol [13]. In the cluster set up phase, few nodes are selected as the cluster head nodes and re-established in each round. The role of cluster head is changed among the nodes during each round in order to achieve the load balancing among the sensor nodes. After selection, a cluster head receives aggregates and transmits data to the sink. Therefore, the cluster head depletes its energy faster as compared to other nodes. However, as the role of cluster head changes after every round, energy utilization is well balanced amid nodes in the network.

There is a multi-hop transmission of data packets from member nodes to the cluster head. A construction graph is formed within a cluster. Using stochastic constructive techniques, ants build solutions while moving on the

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construction graph. To accelerate the search process, ACO uses search experience (called pheromone) with domain knowledge (called heuristic information). Initially, ants are positioned at random cluster members. Here, the ants find an optimal path from members to the cluster head and member nodes choose that path for data transmission.

The proposed method SAS-ACO (sleep awake scheduling and ant colony optimization), presents a clustering and ant colony optimization based sleep/awake scheduling strategy for heterogeneous sensor network. It discovers the shortest optimal path between the cluster head and its member nodes.

- In the beginning of the network, P1 % of the total nodes are kept in the sleep mode.
- Initially, all the nodes have enough energy to perform all the functions. The threshold energy of the nodes is calculated according to the transmission range of a node and its energy consumption for different functions.
- The clustering process takes place, some nodes are selected as the cluster heads while the others are selected as the cluster members.
- For all clusters, an optimal path is chosen between the cluster head and its members by using the algorithm 5.2.
- All the cluster members transmit data to the cluster head by using the optimal path. The cluster head aggregates the received data and transmits to the sink.
- Calculate the residual energy of all nodes, if enough energy is left. Then the next round begins and the residual energy of a node is compared to the threshold energy. Now the residual energy of all the nodes is different, due to their role and position in the network. For example a cluster head will consume more energy and the nodes that were selected as the intermediate nodes of the optimal path in the previous round, have lesser energy as compared to left over nodes. If the residual energy of all the nodes is larger than the threshold energy, the next round starts. This happens in the initial rounds. Over time, energy of some nodes falls below the threshold energy level.
- When the energy of a node falls below a threshold value, put it in the sleep mode and awake one node from the set of sleep nodes. If two nodes are turned into sleep mode, awake two nodes from the sleep set and so on. At any instance of time, no more than P1% of nodes can be in sleep mode.
- The process can continue till the sufficient energy is available in the network.

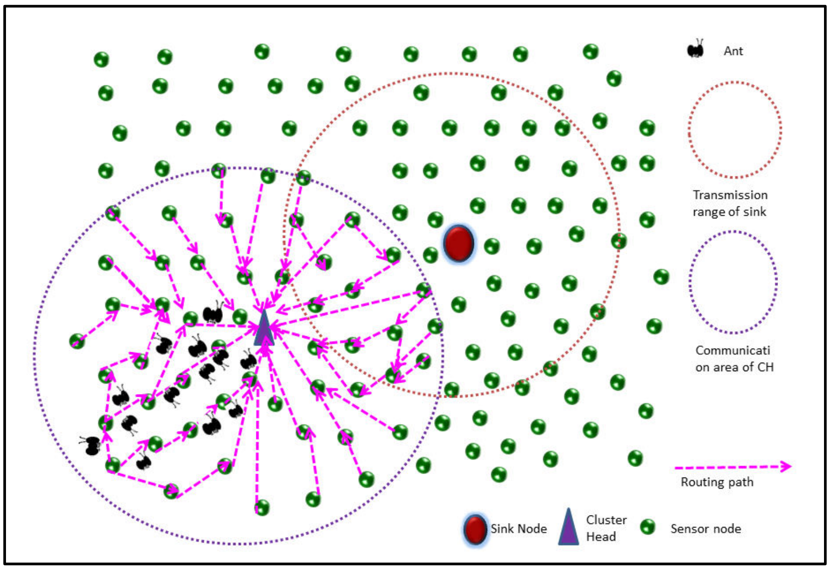

Fig. 1: Selection of an optimal route between the cluster head and its members

The residual energy of the network has been evaluated in terms of the remaining energy of all the nodes per round in the network. Due to sleep-awake scheduling, there is sufficient number of alive nodes for a large number of rounds. If we consider the probability of electing a cluster head as 0.1, then by proposed method, we have approximately 10 cluster head per round in a 100 node network. Out of these 10 cluster heads, 5 are normal and 5

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are advanced nodes. We have enough number of cluster heads available in the network. Further, each of the associated clusters follows the ACO strategy to save energy. There is very low energy consumption in the network until the death of the first node. However, the energy consumption in a network with lesser energy.

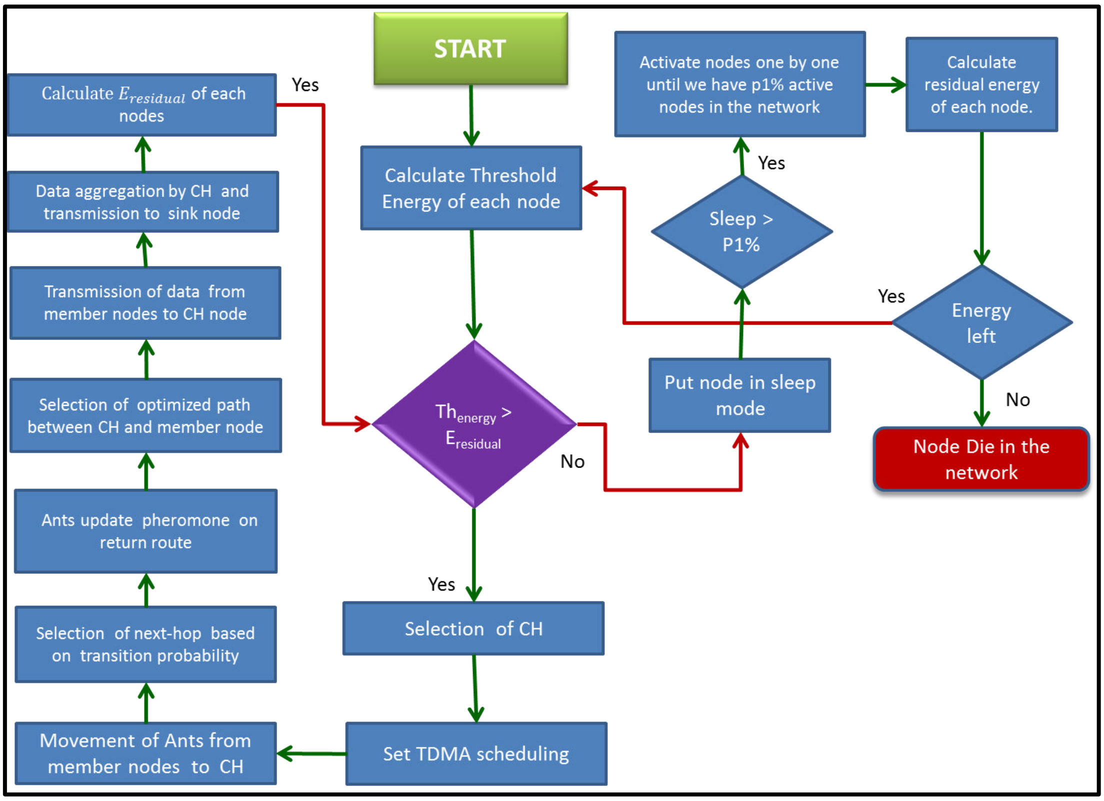

Fig. 2: Flowchart showing the complete processing of SAS-ACO strategy

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IV. EXPERIMENT RESULTS

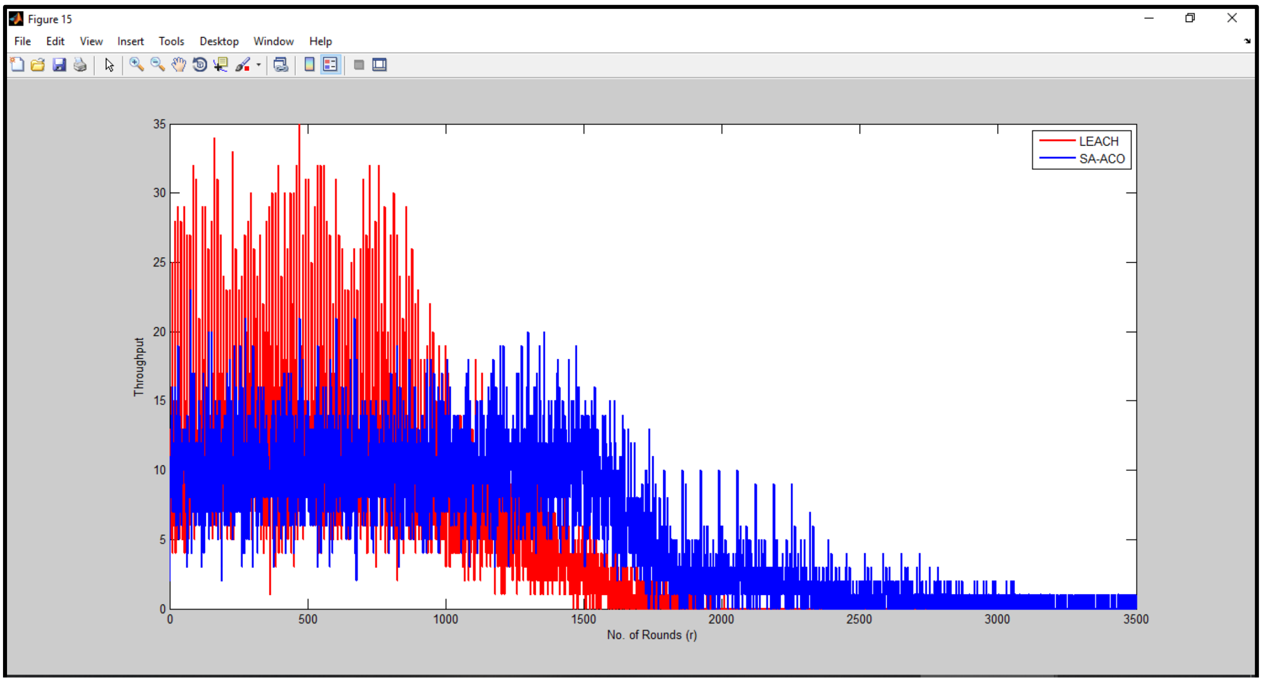

Fig. 3: Throughput of the Network

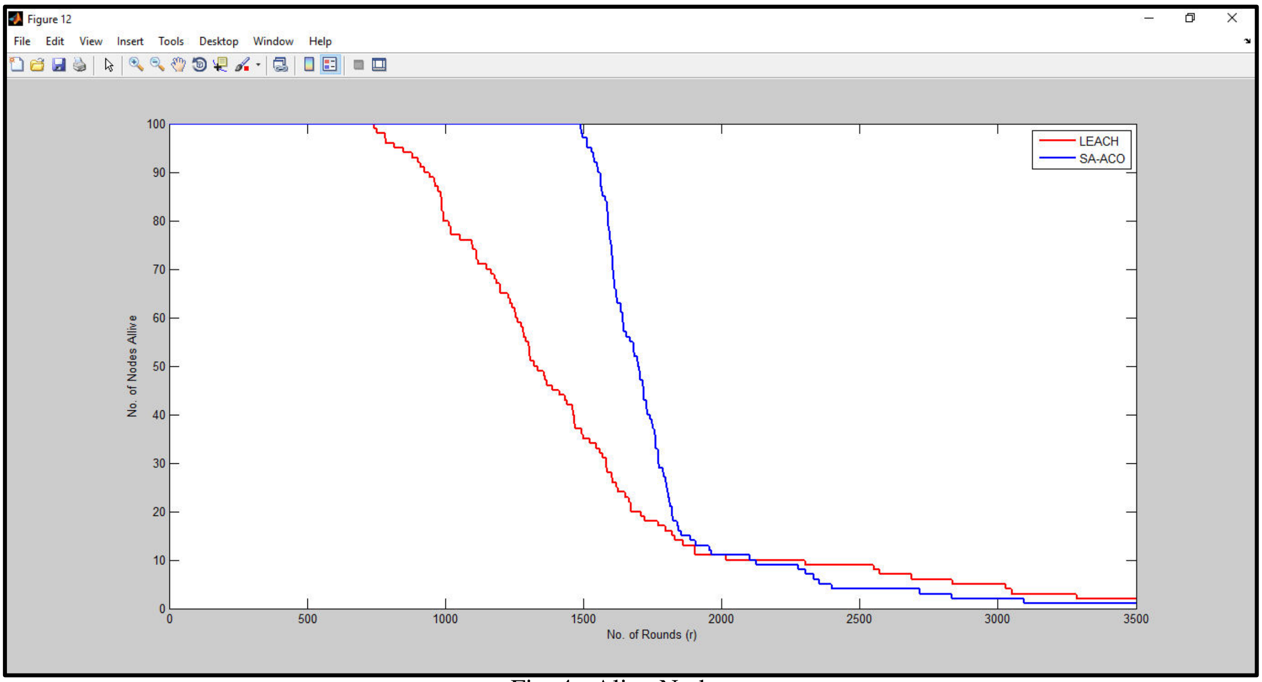

Fig. 4: Alive Nodes

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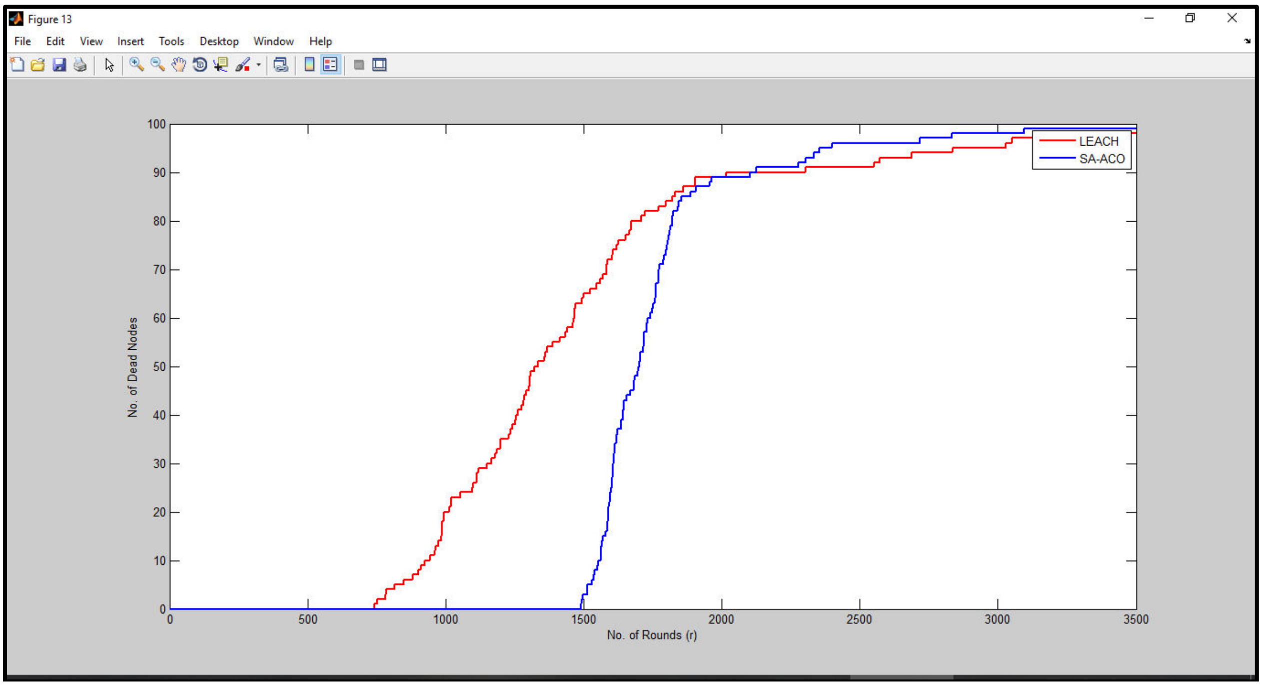

Fig. 5: Number of Dead Nodes

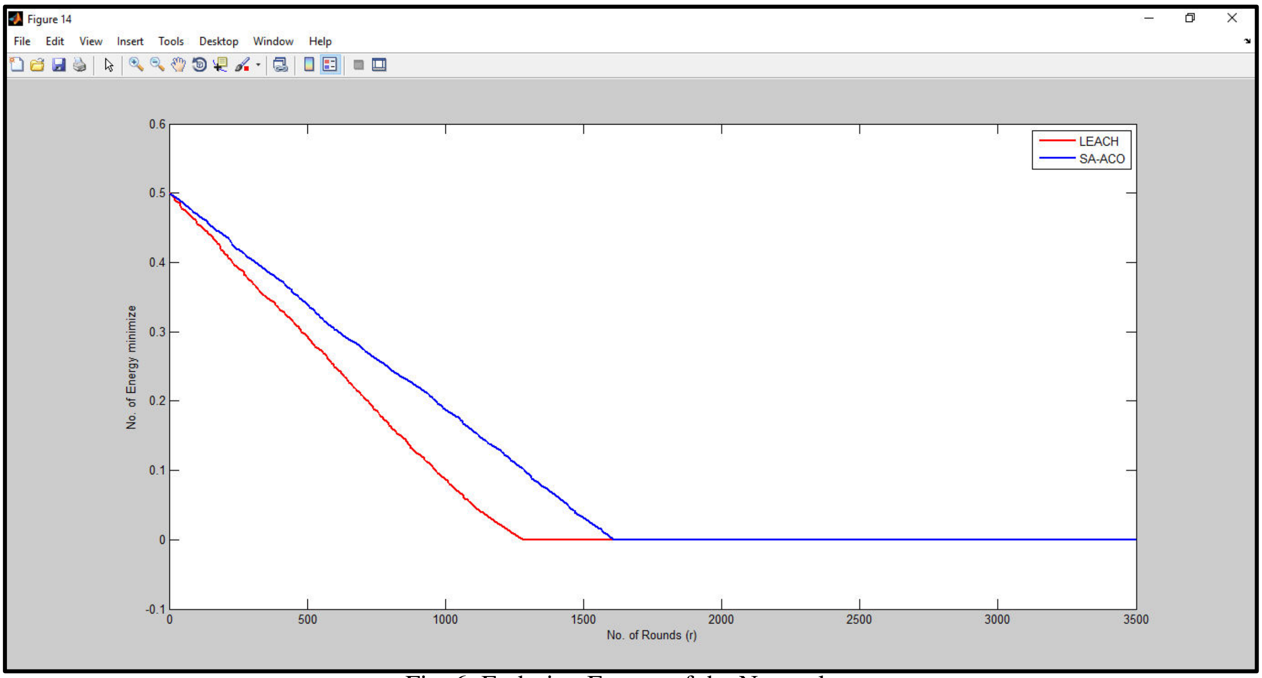

Fig. 6: Enduring Energy of the Network

The number of packets transmitted for SA-ACO protocol is more as compared to LEACH protocol. The reason behind this is the efficient energy consumption within the cluster. Member nodes always use an optimal path for transmission. A packet arrives at the CH, with less or almost no delay. In later rounds, if an intermediate node dies, member nodes can opt for an alternative path. Moreover, advanced nodes have much extra energy and these nodes are available in the network for a longer time. In case of homogeneous network, the number of available nodes is very less in later rounds. As a result, the number of packets transmitted to the cluster head drop sharply.

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V. CONCLUSION

In SAS-ACO protocol, all the nodes within a cluster transmit to the cluster head and these nodes use an optimized path for the transmission. This path is selected on the basis of various criteria i.e. residual energy, distance, pheromone trails, etc. that balances the workload among all the member nodes. Moreover, in SA-ACO, a node goes into sleep mode when its residual energy is less than the energy required for transmission while in LEACH there is no sleep state, and it led to high energy consumption. Sleep-awake scheduling is based on the threshold energy level of the nodes. An optimal path is produced by the ant colony optimization method between a cluster member and its cluster head, in order to reduce energy consumption within the cluster. SAS-ACO has parameters like ρ,α, β,μ that need to be set in order to improve performance of the algorithm. We have concluded the optimal values of these parameters and used these values in the network scenario for simulations. Simulation results illustrate that SAS-ACO consumes less energy as compared to LEACH protocol.

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