Hybridization Optimization Approach For Energy Efficiency on Wireless Sensor Network

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***Abstract*—**Wireless network is the one in which, computer devices communicate with each other without any wire. The communication medium between the computer devices is wireless. When a computer device wants to communicate with another device, the destination device must lays within the radio range of each other. Users in wireless networks transmit and receive data using electromagnetic waves. Recently wireless networks are getting more and more popular because of its mobility, simplicity and very affordable and cost saving installation. With the advancement in communication and internet technologies, recently there have been many research efforts in the area of Wireless Sensor Networks (WSNs) to conserve energy. Each sensor node consists of a processing capability, multiple types of memory, RF transceiver, and a power source. WSNs have unique characteristics for example, denser level of node deployment, higher unreliability of sensor nodes, and severe energy, computation, and storage constraints that present many new challenges in the applications of WSNs. In the past decade, WSNs have received tremendous attention from both academia and industry all over the world. Energy consumption is one of the main problems in the sensor networks and if the consumption of energy increases then the node failure increases which results the failure of the nodes in the sensor networks. So the energy must be conserve for high throughput and packet deliveries which must be low for the high performance of the system. In this paper, energy efficient weighted clustering process for the aggregation of the data to the destination in the energy efficient process has been performed. For this purpose, the hybrid optimization using firefly and moth flame optimization algorithms has been implemented. And the results are evaluated on the basis energy consumption, number of clusters, packet delivery and end delay.

Keywords*—WSN; QOS; routing protocol; MANET; FA*

I. Introduction

The term sensor network is referred to a heterogeneous system combining tiny sensors and actuators with general purpose computing elements. The Application domains of Wireless Sensor Network are diverse due to the availability of micro-sensors and low-power wireless communications. Unlike the traditional sensors in the remote sensor network, a vast number of sensors are densely deployed. These sensor nodes will perform significant signal processing, computer, and network self-configuration to achieve scalable, robust and long-lived networks. More specifically, sensor nodes will do local processing to reduce communications and consequently, energy costs. We believe that most efficient and adaptive routing model for WSN is cluster based hierarchical model. For a cluster based sensor network the cluster formation plays a key factor to the cost reduction where cost refers to the expense of setup and maintenance of the sensor networks [1]. There have been large amounts of research undertaken during the past decade in the areas of adhoc networking and wireless sensor networks (WSNs) and significant progress has been achieved. Possible civilian use-cases for such networks include industrial plant monitoring and environmental monitoring [2].

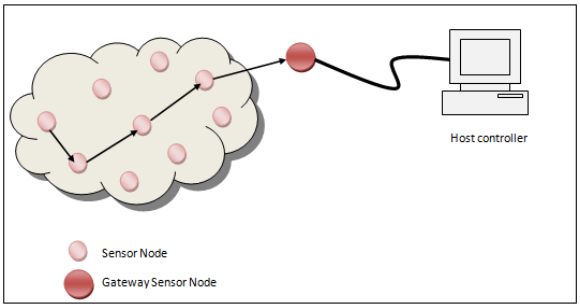

Fig. 1 WSN

II. Ease of Use

A. Important factors of WSN

The performance of wireless sensor networks is based on the following factors:

- Latency: Latency is defined by how much time a node takes to sense, or monitor and communicate the activity. It also depends on the application at hand. Sensor nodes collect information, process it and send it to the destination. Latency in a network is calculated based on these activities as well as how much time a sensor takes to forward the data in heavy load traffic or in a low density network.
- Scalability: Scalability is an important factor in wireless sensor networks. A network area is not always static, it changes depending upon the user requirements. All the nodes in the network area must be scalable or able to adjust themselves to the changes in the network structure depending upon the user [4].

- Energy Awareness: Every node uses some energy for activities like sensing, processing, storage and transmission. A node in the network should know how much energy will be utilized to perform a new task that is submitted, the amount of energy that is dissipated can vary from high, moderate to low depending upon the type of functionality or activity it has to perform.
- Node Processing Time: It refers to the time taken by the node in the network for performing all the operation starting from the sensing activity to processing the data or storing data within the buffers and transmitting or receiving it over the network.
- Transmission Scheme: Sensor nodes, which collect the data transmit it to the sink or the base station either using the flat or in multi hop routing schemes.
- Network Power Usage: All the sensor nodes in the network use a certain amount of network power which helps them to perform certain activities like sensing or processing or even forming groups within the network area. The amount of energy or power utilized by the sensor nodes or a group of sensors within the network is known as network power usage.

B. Characterstics of Wireless Sensor Networks

The wireless sensor network is the most adaptive communication network that is used in many applications and organizations: military, medical, and environmental, for the monitoring of critical infrastructure in the affected areas and hostile, WSN has several characteristics are as below:

- Power consumption constraints for nodes using batteries or energy harvesting.
- Ability to cope with node failures.
- Mobility of nodes.
- Dynamic network topology.
- Communication failures.
- Heterogeneity of nodes.
- Scalability to large scale of deployment.
- Ability to withstand harsh environmental conditions.
- Ease of use [4].

C. Routing Protocols For Wsn Networks

Routing protocols have a large scope of research work when implemented in a WSN, because the functioning of these protocols depends upon the type of network structure designed for the application or the network operations carried out using these protocols for a specific application model. Figure 2 shows the protocol classification or a routing taxonomy for routing protocols which are further sub-divided into subcategories.

1) Structyre Based Routing Protocol: Routing protocols are divided into structure-based routing protocols, which are in turn classified as flat routing, hierarchical routing and location-based routing. The protocols which fall under these categories work with respect to the design constraints given for the network structure or area.

a) Flat Routing: This is a routing technique in which all the sensor nodes play the same roles, such as collecting data and communicating with the sink, i.e. all the data collected in the remote area can be same or duplicated as all the sensor nodes work in the same way.

b) Hierarchical Routing: In this routing technique all the routing sensors in the network are clustered and a cluster head collects and aggregates the data and checks for redundancy of the data that is collected before it is sent to the sink. This saves communication and processing work and also saves energy.In this routing technique all the routing sensors in the network are clustered and a cluster head collects and aggregates the data and checks for redundancy of the data that is collected before it is sent to the sink. This saves communication and processing work and also saves energy.

c) Location based: In location-based routing, all the sensor nodes are addressed by using their locations. Depending upon the strength of the incoming signals, it is possible to calculate the nearest neighboring node's distance. Due to obstacles in the network often the signal strength becomes weaker and nodes find it difficulty in finding the nearest neighbor nodes, SMECN performs well in such situations also by creating a sparse graph of the network nodes before transmitting to the next node. All the nodes in the network exchange this data in order to know about neighboring nodes. This is useful for communicating and transferring information.

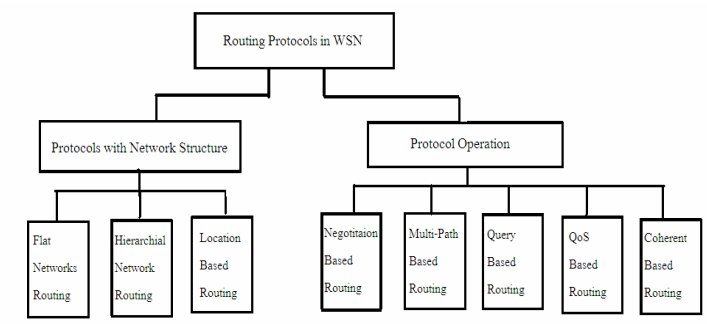

Fig. 2 Routing Protocols For Wsn Networks

2) Protocol Operation Based Routing Protocols:

a) Multipath based: These protocols are efficient in handling multiple paths. Nodes send the collected data on multiple paths rather than using a single path. The reliability and fault tolerance of the network increases as there is as long as it is possible an alternative path when the primary path fails.

b) Query based: Query-based routing propagates the use of queries issued by the base station. The base station sends queries requesting for certain information from the nodes in the network. A node which is responsible for sensing and collecting data reads these queries and if there is a match with the data requested in the query it starts sending the data to the requested node or the base station. This process is known as Directed Diffusion [6] where the base station sends interest messages on to the network.

c) Negociation Based: These protocols use high-level descriptors coded in high level so as to eliminate the redundant data transmissions. Flooding is used to disseminate data due to the fact that flooding data are overlapped and collisions occur during transmissions. Nodes receive duplicate copies of data during transmission. The same data content is sent or exchanged again and again between the same set of nodes and a lot of energy is utilized during this process.

d) Quality of Service (QOS): In this type of routing protocol both quality and energy have to be maintained within the network. Whenever a sink requests for data from the sensed nodes in the network, the transmission has to satisfy certain quality-of-service parameters such as for example bounded latency (data has to be sent as soon as it is sensed without delaying any further) and bandwidth consumed. Sequential Assignment Routing (SAR) [26] is one of the first routing protocols that use the notion of QoS in routing decisions. Routing decision in SAR depends on three factors: energy consumption within the network by the sink and the nodes, QoS of each path in the network and priority level of each packet sent.

e) Coherent Based: In a WSN the sensor nodes collect data and send it to the nearest neighbors or the sink within the network. In this process, the processing of the collected data is the most important event. There are two types of data-processing techniques followed within the network structure: coherent and non-coherent data processing based routing. All the nodes within the network collect the data and process it before sending to the next nearest node for further processing. This technique is called non-coherent data process routing and the nodes that perform further processing on the data are called aggregators. In coherent routing, after minimum processing the data is forwarded to the aggregators.

D. Literature Review

The literature review of Wireless sensors is given below:

D. Alsoufi et al. (2012) has discussed that wireless sensor networks are becoming significantly vital to many applications, and they were initially used by the military for surveillance purposes. One of the biggest concerns of WSNs is that they are very defenseless to security threats. Due to the fact that these networks are susceptible to hackers; it is possible for one to enter and render a network. For example, such networks may be hacked into in the military, using the system to attack friendly forces.

R. R. Athna et al. (2013) has proposed Energy Efficient Cluster Head Selection Protocol in Mobile Wireless Sensor Network (EECHS-MWSN). The cluster-head nodes are selected from the residual energy, lowest mobility factor a density of the node. It is also used that the Gateway nodes are acting as an intermediate node to transfer the data to the Base station. An improved description of LEACH- Mobile protocol called EECHS-MWSN which aims to reduce energy consumption in Mobile, wireless sensor network and extend the lifetime of the network.

H. Guangjie et al. (2013) has introduced the energy, renewable property and further proposes a novel 2-hop geographic node-disjoint multi-path routing algorithm TPGFPlus in energy consumption balanced duty-cycled WSNs. Analysis and simulation results show that TPGFPlus out-performs previous algorithm TPGF on finding more average number of paths and shorter average length of paths, yet without causing additional energy consumption.

J. Bo et al. (2013) has discussed about surveillance system, while tracking the object, nodes operate in a duty cycling mode, causing negatively impact on the energy efficiency of the node. Hence the author proposed a Probability based Prediction and Sleep Scheduling protocol (PPSS) to improve energy efficiency of proactive wake up. The implemented system improves energy efficiency by 25-45 percent (simulation based) and 16.9 percent (implementation based) when comparing with existing algorithms.

W. Ye et al. (2013) has made an attempt for designing a wireless sensor network involving the extraction of Pascal Graph features. The standard task involves designing a suitable topology using Pascal Graph. As per the definition of interconnection network it is equivalent that a suitable graph can represent the different computer network topologies very efficiently. Different characteristics of Pascal Graph Topology have been discovered and used in network topology design. Since Pascal Graph gives better results in terms of finding the dependable and reliable nodes in topology, it has been considered for network analysis. Moreover, the author has proposed a methodology that involves the Pascal Graph Topology for wireless sensor network which can analyze and represent the network and help with routing.

M. Dener et al. (2014) has described that in recent years, wireless sensor network (WSN) has been employed in many application areas such as monitoring, tracking, and controlling. For many applications of WSN, security is an important requirement. However, security solutions in WSN differ from traditional networks due to resource limitation and computational constraints. This paper analyzes security solution like TinySec, IEEE 802.15.4, SPINS, MiniSEC, LSec, LLSP, LISA, and LISP in WSN. The author has also presented characteristics, security requirements, attacks, encryption algorithms, and operation modes.

Z. Chunsheng et al. (2014) have explored geographic routing in duty cycled mobile WSNs and proposed two geographic-distance based connected-k neighborhood (GCKN) sleep scheduling algorithms. The first geographic-distance based connected-k neighborhood for the first path (GCKNF) sleep scheduling algorithm minimizes the length of first transmission path explored by geographic routing in duty-cycled mobile WSNs. The second geographic-distance based connected- k neighborhood for all paths (GCKNA) sleep

scheduling algorithm reduces the length of all paths searched by geographic routing in duty-cycled mobile WSNs.

M. Dener et al. (2014) has proposed a new approach to ameliorate a threshold distributed energy efficient clustering protocol for heterogeneous wireless sensor networks by excluding closest nodes to the base station in the clustering process by simulation in MATLAB that the proposed approach increases obviously the number of the received packet messages and prolongs the lifetime of the network compared to TDEEC protocol.

M. P. Bhoyar et al. (2015) has discussed about increasing the network efficiency & reducing the power consumption are important issues in the design of applications & protocols for wireless sensor network. Sleep scheduling & routing protocol provide efficient communication with less power consumption. The author addressed the routing protocol for static network, which reduces the computation time & power consumption. Proposed system in practice, suitable for small & medium sized networks.

L. Xiao et al. (2015) has discussed about the power consumption and energy efficiency of wireless sensor network are the significant problems in the Internet of Things network which consists of the network topology optimization based on a complex network theory to solve the energy efficiency problem of WSN. The author has proposed the energy efficient model of WSN according to the basic principle of small world from complex networks. The Small world network has clustered features that are similar to that of the rules of the network, but also has similarities to random networks of small average path length. It can be utilized to optimize the energy efficiency of the whole network. The optimal number of multiple sink nodes of the WSN topology is proposed for optimizing energy efficiency. Then, the hierarchical clustering analysis is applied to implement this clustering of the sensor nodes and pick up the sink nodes from the sensor nodes as the clustering head. Meanwhile, the update method is proposed to determine the sink node when the death of certain sink node happened which can cause the paralysis of the network. Simulation results verify the energy efficiency of the proposed model and validate the updating of the sink nodes to ensure the normal operation of the WSN.

Z. Chen et al. (2017) has discussed about a novel Energy efficient Broadcast scheme with adjustable broadcasting radius is proposed aiming to improve the performance of network upgrade. The author described about the non-hotspots sensor nodes take full advantage of their residual energy caused in data collection period to improve the packet reception probability and reduce the broadcasting delay of code packet transmission by enlarging the broadcasting radius, that is, the transmitting power. The theoretical analyses and experimental results show that, compared with previous work, our approach can averagely reduce the Network Upgrade Delay (NUD) by 14.8%–45.2% and simultaneously increase the reliability without harming the lifetime of network.

H. Oudani et al. (2017) has discussed about the wireless sensor networks, the energy consumed by each node of the network influences the lifetime of the networks, more than the consumption of energy increases more than the lifetime of the networks decreases, this is why the increase of the lifetime of the networks requires a strategy (protocol) which reduces the power consumption of the transmission or reception of data by the sensor nodes. In recent years much research has been done to maximize a lifetime of network sensor. equations are an exception to the prescribed specifications of this template. You will need to determine whether or not your equation should be typed using either the Times New Roman or the Symbol font (please no other font). To create multileveled equations, it may be necessary to treat the equation as a graphic and insert it into the text after your paper is styled.

III. Problem formulation

With the popularity of cell phones and smart devices, computing devices have become cheaper, mobile and more distributed in daily life. Wireless Sensor Network (WSN) is a collection of sensor nodes organized into a co-operative network to accomplish a common task. Each sensor node consists of a processing capability, multiple types of memory (program, data or flash memories), RF transceiver, and a power source. In addition, the nodes accommodate sensors and actuators [1]. Wireless Sensor Network is a collection of sensor nodes organized into a cooperative network to accomplish a common task. Each sensor node consists of a processing capability, multiple types of memory, RF transceiver, and a power source. WSNs have unique characteristics for example, denser level of node deployment, higher unreliability of sensor nodes, and severe energy, computation, and storage constraints that present many new challenges in the applications of WSNs. In the past decade, WSNs have received tremendous attention from both academia and industry all over the world. Energy consumption is one of the main problems in the sensor networks and if the consumption of energy increases then the node failure increases which results the failure of the nodes in the sensor networks. So the energy must be conserve for high throughput and packet deliveries which must be low for the high performance of the system. The proposed hybrid optimization approach will use to resolve the above mentioned issue and performance of the proposed system will be evaluated by using the energy consumption, number of clusters and packet delivery ratio.

A. Research Objectives

A Mobile Ad Hoc network is a self-configuring networks consisting of mobile nodes without any fixed infrastructure. These wireless devices communicate with each other directly if they are in the same network coverage area. If they are out of the coverage range, the communication will require the formation with the help of cooperatives. The objectives of the research work are:

- To study the basics of the sensor network and the stability of connectivity in high dense environments
- To perform the energy efficient weighted clustering process for the aggregation of the data to the destination in the energy efficient process

- To implement the hybrid optimization using firefly and moth flame optimization algorithms and evaluate the performance in terms of energy consumption, number of clusters, packet delivery and end delay.

IV. REsults

Sensor nodes in WSNs should be low-cost and should have small form-factor. This restricts sensor nodes in many ways as they have limited energy, short transmission range, relatively slow CPU and small memory. These limitations bring out many challenges unique to WSNs, such as very low power consumption. Restoration is one of the main challenge in an optimize manner in the wireless sensor networks. The faults can be in any way like energy consumption failure, high packet drops, due to physically conditions and due to high environmental changes. So this thesis deals with the hybrid approach of two optimization scenarios for achieving high fault failure tolerances ad achieving high lifetime and message transfer with high connectivity restorations. The result explanation of the proposed approach is discussed below:

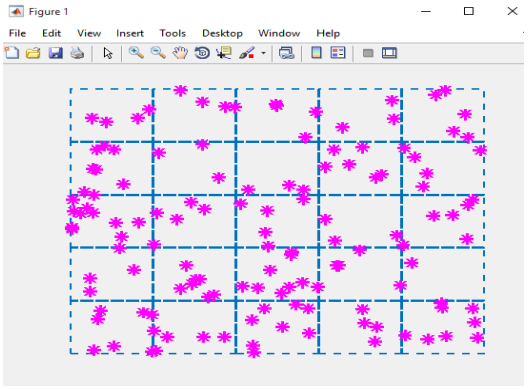

Fig. 3 Network Creation

The figure 3 deals with the network creation in which the nodes are deployed in the network with their ids as shown in the figure. The nodes are deployed using evaluation of x and y locations which will further work as a processing unit. The nodes are deployed uniformly in the cluster.

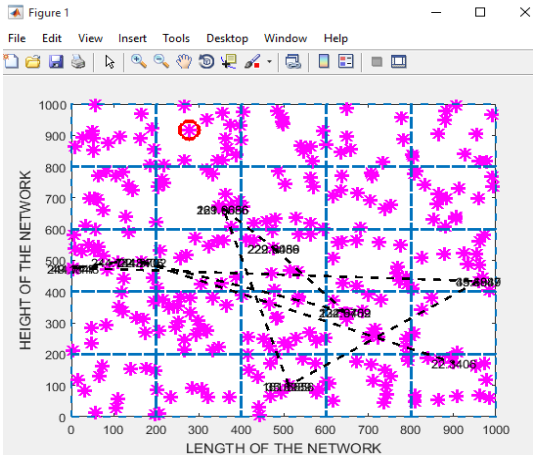

Fig. 4 Cluster heads routing

The figure 4 shows the nodes routing nodes in the network. These nodes act as the cluster nodes through which the routing will take place. The cluster heads act as the route nodes which are responsible in sending the information from source to the destination and shows that the simulation is taken in terms of total number of rounds through which we will able to detect the lifetime of the network.

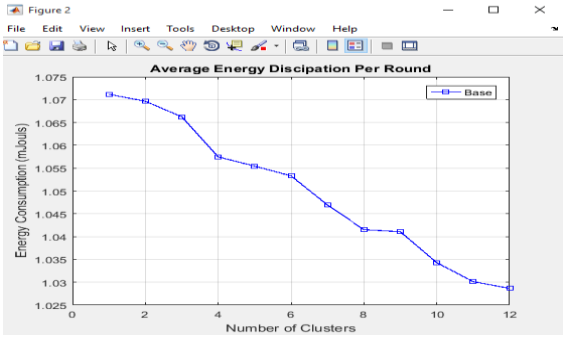

Fig. 5 Energy dissipation

The figure 5 shows the dissipation of the energy and shows that the weighted average clustering approach is able to achieve 1.03 mJ of energy consumption per round which are taken by the cluster heads. As the number of rounds increases the energy consumption also decreases. This is one of the important parameter which is able to evaluate the lifetime of the network in terms of the energy consumption.

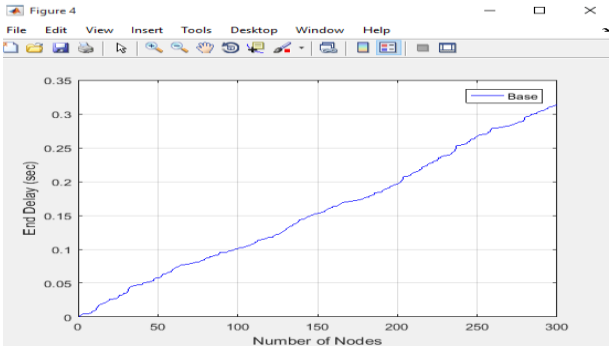

Fig. 6 End delay (sec)

The figure 6 shows the end delay of the base approach using weighted clustering approach and shows that the base approach is able to achieve less end delay with respect to the total number of nodes participating in the evaluation of the network lifetime.

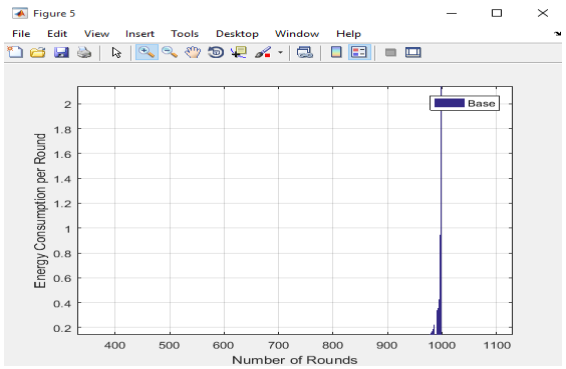

Fig. 7 Energy consumption per round (Base approach)

The figure 7 shows the energy consumption per round with respect to the number rounds for the base approach and shows that the system is able to achieve high energy consumption of 2.5 mJ.

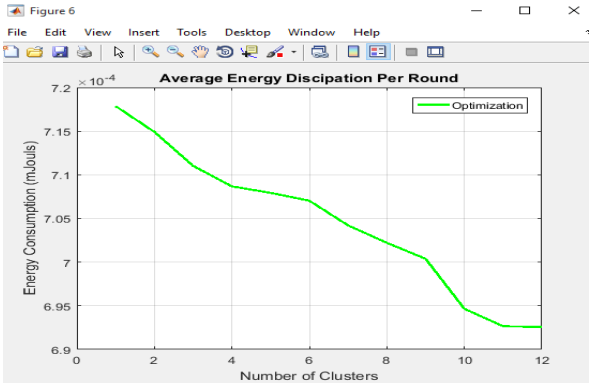

Fig. 8 Average Energy consumption

The figure 8 shows the energy consumption in milli jouls with respect to the number of clusters and shows that the proposed approach is able to achieve less energy consumption which is 0.00069 mJ which is better than the proposed approach and shows the robustness of our proposed system.

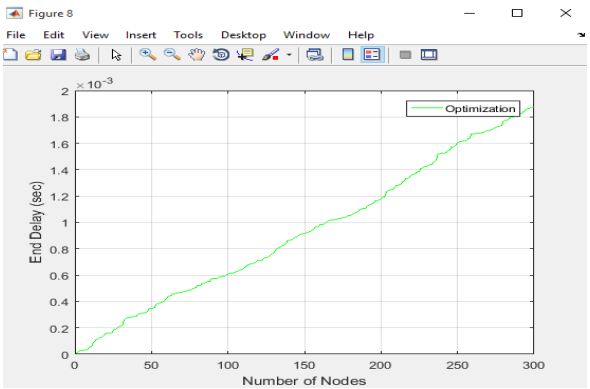

Fig. 9 Proposed End Delay (sec)

The figure 9 shows the end delay of the proposed hybrid approach which is done using moth flame and firefly optimization shows that the proposed approach is able to achieve less end delay than the base approach which is one of the important parameter to achieve high network lifetime.

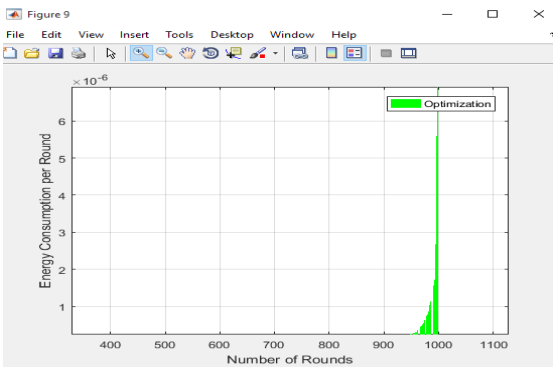

Fig. 10 Energy Consumption Proposed

The figure 10 shows the proposed approach energy consumption per round which is coming very less to achieve high packet deliveries in the efficient manner to get less losses for the high efficient and normalization of packets to be transmitted among the cluster nodes.

TABLE I. Proposed Approach Performance

Parameter	Base	Proposed
Average Energy dissipation	1.025 mJ	0.000694 mJ
End delay	0.32 sec	0.002 sec
Energy Consumption per Round	2.5 mJ	0.00006 mJ

conclusion

With the popularity of cell phones and smart devices, computing devices have become cheaper, mobile and more distributed in daily life. Wireless Sensor Network (WSN) is a collection of sensor nodes organized into a co-operative network to accomplish a common task. Each sensor node consists of a processing capability, multiple types of memory (program, data or flash memories), RF transceiver, and a power source. In addition, the nodes accommodate sensors and actuators. Wireless Sensor Network is a collection of sensor nodes organized into a cooperative network to accomplish a common task. Each sensor node consists of a processing capability, multiple types of memory, RF transceiver, and a power source.

Mobile ad hoc network (MANET) is made up of a set of wireless mobile nodes to form an infrastructure-less network. Here, the number of mobile hosts can communicate with one another via relaying messages among mobile hosts through multi-hop wireless links. MANETs are capable of forming wireless network that can setup a transmission range between the nodes in the network. The mobile nodes can join and leave or change their position anytime inside the network. Designing a routing protocol for MANET depends on various factors like mobility, resource constraint, bandwidth, hidden and exposed terminal problems, and so forth. A Mobile Ad Hoc network is a self-configuring networks consisting of mobile nodes without any fixed infrastructure. These wireless devices communicate with each other directly if they are in the same network coverage area. If they are out of the coverage range, the communication will require the formation with the help of cooperatives.

Energy consumption is one of the main problems in the sensor networks and if the consumption of energy increases then the node failure increases which results the failure of the nodes in the sensor networks. So the energy must be conserve for high throughput and packet deliveries which must be low for the high performance of the system. The proposed hybrid optimization approach has been used to resolve the above mentioned issue and performance of the proposed system also

has been evaluated by using the energy consumption, number of clusters and packet delivery ratio. In the future, the another optimization methods such as Cat Swarm or Bat optimizations can be applied for node selections on sensor network to make more energy efficient.

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