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Optimize Cluster Size and Cluster Head Selection by Hybridization of Tabu Search and Bee Colony Approach

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Abstract- *WSN is a group of nodes that are connected to each other by wireless connection. These type of network work on the dynamic topology of the network because positions of nodes in the wireless network are changing continuously. The nodes in WSN are basically made up of small electronics device which are used for sensing, computing and transmitting the data. The nodes are run on the battery power during communication process. The battery consumption in WSN is very high due to high computation operations on it. In the recent years WSN grows at very high at the research area is also increased in this field to provide effective computation. By considering the network structure routing is categorized into two parts that are flat and hierarchical routing. In this proposed work cluster are made by TABU-ABC (ABCoptimization) on the basis of distance and energy parameters. The cluster head is also selected on the basis of TABU-ABC and TABU in three different metrics. At the end the performance evaluation of the proposed work is compared with the existing approach LEACH on the parameters of Throughput, Dead node, Alive nodes, energy*

Keywords- *WSN, Leach, TABU, ABC*

1. INTRODUCTION

WSN 's thick, low - control, low - control, self - regulating networks collect and multiply natural information in order to enhance the accuracy of sensors and controls over physical conditions in remote locations. Most of the sensors of a computer are supposed to have certain limitations regarding the source, power and memory and figure capabilities of their energy. This includes a door as returns the cableed world and dispersed nodes to the wireless network. It can also be defined as a gadget device which can transmit data from a field observed through wireless connection. The information is transmitted via various entry nodes and is transmitted through various networks, such as wireless Ethernet. The networks are used to track sound, weight , temperature and so forth in physical or ecological conditions. The battery limit of WSN nodes is low. With the rapid and parallel increase in the use of WSN, this technology faces many key energy challenges according to the limited lifetime of the batteries, since each of these batteries depends on the energy demand for basic operations. An interruption of the node can lead to the complete system shutdown. Active mode, idle and sleep mode are the basis for the nodal operation. In the case of active modes, the transmission or retrieval of data consumes energy. In idle mode, the node uses the same energy that the active node does, while in dwell mode, the node is shut down to save energy. The use of vitality in a productive way is a most usual problem to construct WSN's life expectancy. As the WSN use expands at a very rapid rate and numerous sensor varieties with limited batteries are used for tracking the target, physical condition etc. Such applications require rapid matching of sensor nodes. The following steps are used by WSN to ensure that the system is safe for longer use.

Scheduling the nodes state (receiving, idle or sleep, and transmitting).

Changing the range of transmission between the sensing nodes used in the process.

To reduce the redundant or the unwanted data.

Use of efficient data collecting methods and the routing protocols.

1.1 WSN: REQUIREMENTS

There are a few such requirements that must be applied to most of the application of the sensor network.

(a) Network size: Most of the applications requires a larger network covering more area and therefore helps in monitoring large events.

(b) Lifetime: The basic need of extending the duration of the WSN is of greater importance as the sensors are not accessed after the process of their deployment.

(c) Minimizing the faults: A network of faulty nature uses various sources to generate more forms of incomplete data or information. In context of sensors, it generally refers to monitor such an environments i.e. broken and many of its events are missing. In case of applications relying on transmitting to the sink, it usually means that the packet loss is very high, and the event knowledge is of incomplete nature, therefore the data gathered is not or reliable nature. So, this condition must be kept in mind that for a reliable collective form of event to its sink plays a significant role on WSN technology. So, in communication protocols such type of requirements explains the following criteria-based strategies:

Scalability: The protocol used for the process of communication must be of reliable nature such as maintaining and establishing the connectivity among each of the sensor. When the size of the sensor becomes large, the protocol must perform in a normal way.

Reliability: In terms of packet loss, it represents one of the major concern for providing a high level of efficiency in control and monitoring systems. Therefore, it is desired to take account of multi-hop availability, employing techniques which are highly energy efficient which would further improve the lifetime of the network.

Multi-hop communication compatibility: In this case the sensors do not communicate with the sinks directly. So, it is usually preferred that the sensors use the other neighbor sensors as hops for the process of communication.

Lower energy consumption: The process of energy consumption should be slow between the sensors and the sink in order to increase the lifetime of the working sensor.

Latency: This is usually defined by the time taken by the node to monitor, communicate, and sense the working operation or activity. The nodes collect the data, processes it and further send it to the receiver or the destination place. The latency is based on the working activities including the time taken by sensor to send the data in low density or heavy load traffic network.

Processing Time of Node: It highlights the performing time of the sensor node starting from the initiation of the operation, sensing, processing or storing data, and receiving or transmitting the data over the network.

Transmission Scheme: The nodes of the sensor collect the data and transmit it to the base station or the sink using either a multi-hop or flat schemes.

Network Power Usage: It represents the power or energy used by the sensor nodes which helps them to perform the allotted activities such as processing, sensing or forming the groups within the area specified.

1.2 WSN ARCHITECTURE

The architecture of WSN technology comprises of the following:

1.2.1 WSN: Model

The architecture of WSN technology is based on the OSI architectural model. It basically includes three cross layers and five normal layers as represented in [2, Figure 1.2].The sensor network includes the five layers namely, application, transport, n/w, data link, and physical layer whereas the cross layers namely, task management, mobility management, and power management. These layers accomplishes the network operation and helps in functioning of the sensors together to boost the network efficiency.

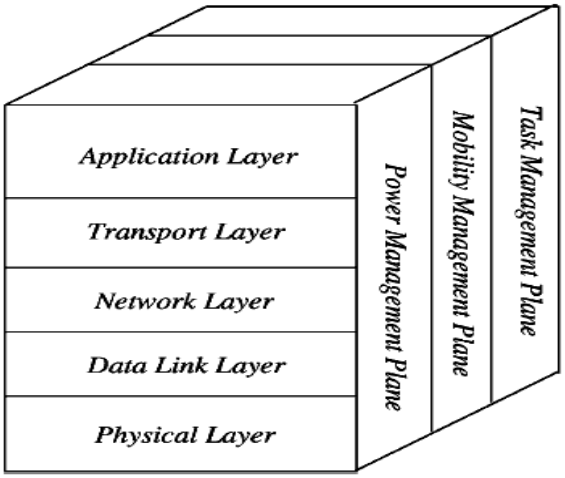

Figure 1.2 Architectural Model

(a) Layer application: It is responsible for network traffic management and provides broad applications software that transforms the data through clean and clear form to provide positive information. (b) Transport layer: The role of this layer to ensure reliable operation and avoid the problem of congestion is organized in various applications such as military, environmental, medical, agricultural etc. The protocols used for this layer use different loss recovery and identification mechanisms, and such a layer is essentially necessary when a network considers or plans to reach certain network types. But this energy efficiency cycle is one of the major reasons why it is not suited to WSN. This layer will typically be directed independently into an event or a packet based operation. PORT, the Preisoriented Reliable Transport Protocol (PSFQ) (Pump Slow Fetch fast) and STCP (Sensor Transmission Control Protocol) are some of the popular protocols used in the transport layer. EOLBREAK (c) Layer network: routing function is the primary goal of this layer. Nonetheless, part of the brain, filters and power conservation applications are the main tasks. The concept for this layer is a basic routing where the essential need is to clarify the redundant and reliable routes that differ from protocol to protocol by persuaded, metric form. Several protocols already exist for such a layer, and flat routing or cane routing may be a time, event, and query-driven form of routing. EOLBREAK (d) Data Link Layer: Typically, it is responsible for data multiplexing operations, MAC and error control , data streams, and it ensures the reliable operation of the data multiplexing system that may be point to point or point to a multipoint. EOLBREAK (e) physical layer: it provides a edge for the transition to the (physical) medium of bit streams. This type of layer is based on frequency generation, frequency selection, modulation and data encoding and signal detection. In areas where power is low , especially in WSNs with low power consumption , low cost, communication and density, it is recommended to improve battery life for operations.

1.2.2 Components of WSN

There are three main components in WSN: nodes, gateways and software. Spatially distributed cluster heads interface with sensors to monitor assets. The collected data transmit to gateway wirelessly, and can operate independently. It is connected to a host system where the data can be collected, processed, analyzed and presented by using software. To extend WSN distance and reliability, special type of measurement node is used such as router node. WSN is a widely used system because of its low costs and high efficiency. WSN contains sensor nodes which basically utilized for detecting, imparting and information preparation. Sensor nodes can be utilized as a part of numerous fields like businesses, military, and farming applications, for example, transportation activity checking, natural observing, keen workplaces and front-line observations. In these applications, sensors are conveyed in a specially appointed way and work independently. In these unattended conditions, these sensors can't be effectively replaced or energized, and vitality utilization is the most basic issue that must be considered. The sensor is a small device which is used to detect the amount of physical parameters, event occurring, measures the presence of an object and then it converts the physical parameters to electrical signal values using electrical actuators.

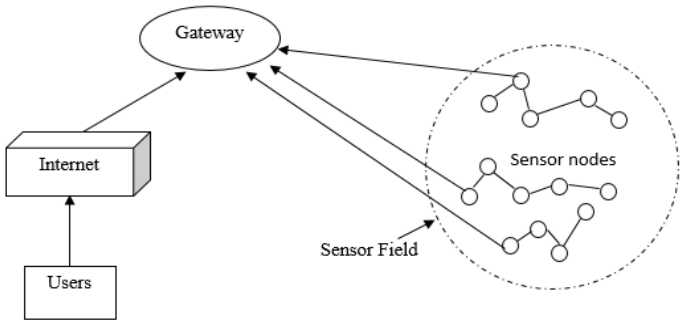

Figure 1.3 Components of WSN

1.2.3 Characteristics of WSN

The characteristics of WSN include the following:

The consumption of power limits for nodes with batteries.

Capacity to handle node failures.

Heterogeneity of nodes and some mobility of nodes.

Large scale distribution scalability.

Ensure and maintaining strict environmental conditions.

Cross-layer design.

Simple/ Easy to use.

1.3 TYPES OF WSN TOPOLOGIES

The different types of network topology [4] are used for the development and deployment in WSN that are point to point, bus, star, tree, ring and mesh etc.

(a) Pont to point network topology: This type of topology is used very commonly and it does not contain central hub part. Here, a sensor node can communicate with another node directly. It contains a single channel for data communication offering a secured path for communication. Each of the device works on a client-server mechanism.

2. RELATED WORK

Shelke, Maya et al. [1] proposed a congestion-aware routing protocol in the WSN. It works on the opportunistic theory and selects the optimized route. For scheduling on the network, it uses sleep mechanism. The proposed protocol reduced the congestion on the network and enhances the node's life and entire network life time. It also reduced the partitioning of the network. It mainly used to provide the appropriate path on the wireless network to the nodes.

Hong, Chao, et al. [2] introduced a Forwarding Area Division and Selection routing protocol in the WSN. This protocol used to classify the collisions in two forms that are same slot collision and distinct slot collision. It reduces the probability of same slot collision and it balances the load by using dynamic load balancing approach. Forwarding area division method is applicable on nodes within the same area and selecting sub area by reducing the number of candidates. This process reduced the same slot collision. Adaptive forwarding area selection is used to channelize the subarea dynamically. The simulation result of the proposed method reduced the packet delay, energy consumption.

Chincoli et al. [3] worked on the transmission power control in WSNby using cognitive methods. In this protocols are divided into two types proactive and reactive. Cognitive protocols that are used this work are fuzzy logic, swarm intelligence and

reinforcement learning. These protocols improve the energy level and quality of service management. This paper also gives information related to benefits of these protocols.

Umar, IdrisAbubakar, et al. [4] The State-free geographical forwarding protocol was introduced that operated on the cross-layering principle and combines routing and media access control layers that restrict consumption of energy. Using handshake mechanisms MAC protocols will mitigate the hidden terminal problem. This process reduced wireless networks end - to - end delays and energy consumption. The author uses a DSG approach to reduce the excessive overhead in the multi - hop network. in this article The findings show that the overhead post, energy consumption and end - to - end delays have been reduced.

Shafieirad et al. [5] proposed the WSNenergy consciousness opportunistic routing protocol. The protocol evaluated the energy available at the node, the distance between the node and the transfer of the data between the nodes. No previous information relating to network topology is required in this protocol. The study also checked with numerical results and shows clearly that the data supply ratio was improved.

Oh, Hoon et al. [6] introduced a slotted sense MAC protocol for timely and reliable data transfer in the WSN. This protocol allocates the sharable slot to each tree which produces topology independent schedule and makes it highly responsive. This protocol provides a reliable data transmission over the nodes. The sharable slot features the proposed method improve its performance by enhancing the data delivery ratio.

Agrawal, Deepika, et al. [7] Fuzzy based unequal clustering algorithm is proposed by the author in this article to enhance the lifetime of the WSN. It balanced the energy consumption by making the unequal clusters. Cluster heads are selected by using the fuzzy logic. Density, energy and base station distance are the input variables of the network. Rank and competition radius are the outputs of the fuzzy system. The performance of the proposed algorithm is compared with existing protocols and found that the proposed algorithm performs better.

Kirubakaran et al. [8] IW- MAC (invite and wait) protocol is proposed to provide efficient WSNs. This protocol is used to provide the efficient use of battery power by sensor nodes. It transfers the minimum control packets and maximum data packet in the given time. Energy on the nodes is used to transfer the data and reduce the overhead of control packets and channel reservation. This approach is used to save the energy during the data transmission on the nodes.

Gowtham et al. [9] proposed congestion control and packet recovery in cross-layer approach. It reduced the problem occurred by the traffic like congestion and contention on the data link layer and transport layer. This protocol recovers the missing packets by storing the copy of the data packets. To avoid the congestion on the network it assigns the priority to the nodes for transmitting data. On the basis of priority, the packets are transmitted to the next node. The packet which has the highest priority transmitted first and then next according to the assigned priority. The performance of the packet is tested on the simulator and gives effective results.

Swain et al. [10] work on the diagnosis of fault in the wireless network and proposed a protocol for it named as Heterogeneous Fault Diagnosis Protocol. This protocol consists of three phases that are clustering phase, fault detection phase, and fault classification phase. This method detects the faulty nodes and classification is done by using probabilistic neural network protocol. The simulation result of the proposed method is tested on NS-2 simulator.

Huang, Haojun, et al. [11] The Author proposes to provide the WSN with an efficient and scalable energy efficient multicast geographical routing protocol (EMGR). It is a multicast tree created by the target set and the energy source node. It protocol offers low power consumption, overhead processing and a high package delivery ratio.

Kumberg, Timo, et al. [12] proposed a simple and effective cross-layer routing protocol called as T-ROME. In this nodes are containing wake up receivers. This by the protocol used to save energy skipping nodes during data transfer. In this protocol, Markov chain model is also used for verification. This protocol enhanced the performance of the WSN.

Krishna et al. [13] uses sensor- media access control protocol and LEACH to provide energy efficient WSN. In this method, LEACH is used for adaptive clustering of the nodes in remote sensor systems. This method uses TDMA based MAC convention to adjust utilization. In these work different types of LEACH is also used to enhance the performance.

Tan, Cheng Kiat, et al. [14] introduced FAEM data collection protocol which is used for energy efficient multicast multichannel routing in WSNs. It works on the basketball net topology in which it establishes a table for each node and also pre-assigns the channel which is different from the neighbor nodes. Time is divided into duty cycle and each cycle consists of

two phases. The first phase called iterative scheduling phase and second phase called as slot-based packet forwarding phase. In this network tree upload nodes are called parent node and download nodes are called child node. Results of the proposed method give low energy consumption, low latency, and high data reliability.

Bahbahani, et al. [15] proposed cooperative clustering protocol to enhance the longevity of energy harvesting based WSN. It maintains the energy consumption between the cluster heads and nodes according to the duty cycle. In this TDMA approach is used with the cross-layer approach. Performance of the proposed system is analyzed by using parameters bandwidth utilization, latency, and energy consumption.

Saleh, Ahmed et al. [16], Sen, GB Zionna et al. [17] Multi-aware Query Driven routing protocol is proposed for WSN which is based on the neuro-fuzzy system. This protocol focused on the life of the sensor, delay transmission of data and total cost of network and path on the network. Fuzzy rules are used to select the proper path. The performance evaluation is done by comparing the proposed protocol with the existing and it provides best data delivery with minimum routing overhead. In [17] Rumor Routing is proposed with fuzzy logic to reduce the energy consumption. It works on the three factors centrality, energy, and distance. Network efficiency is enhanced by using this approach.

Kulshrestha et al. [18] introduced an adaptive energy balanced and energy efficient approach for data gathering in WSNs. This method considers the neighbor nodes and link reliability to determine the energy consumption on nodes. This mechanism reduced the end-to-end delay and energy consumption in the wireless networks. In this work, the author uses Forwarding approach to reduce the excessive overhead in the multi-hop network. The result of the paper shows that it reduced the message overhead, energy consumption, and end-to-end delay.

Zhang, Xiaoying, et al. [19] Energy efficient MAC protocol is proposed for WSNs. It works on the basis of best partnership selection algorithm which considers the energy consumption during the data transmission. It checks the total power allocated to the senders to transmit data packets. This protocol gives congestion free network and nodes consuming low energy.

3. THE PROPOSED METHOD

Step 1: The initial step is to deploy the WSN network, in which we have to set the initial parameters which in our case are the number of nodes, the network area.

Step 2: After deploying, the selection of CH is made by the prediction method, which in our case shall be original LEACH algorithm. The reason for this choice is that LEACH is a TDMA based protocol and each node in t uses a stochastic approach at each round to determine if it will become a cluster head or not and the nodes that have been a cluster head once cannot be a cluster head again.

Step3: Initialization of ABC Optimization (ABC) is done. ABC mimics the leadership hierarchy & hunting mechanism of grey wolves which are 4 basic types namely alphas, betas, deltas & omegas. The basic steps are to search for prey, encircle the prey & attack the prey for hunting.

Step 4: Update the value of α, β, δ in ABC. Where, α is the leader and is responsible for making decisions, β is subordinate to alpha that help α in decision making and reinforce the inputs from alphas to its subordinate groups i.e., gammas & deltas. In order to mathematically simulate the hunting behaviour, we suppose that the alpha, beta & delta have the better knowledge about the potential location of the prey.

Step 5: Once the values of α, β, δ are updated, the optimization process starts. If it is optimized then next steps are started otherwise the control is returned to the Step 3.

Step 6: After the optimization is done, two steps are taken. Firstly if the Search space as obtained after the executing of ABC is less than 3 then the analysis of stability parameters of WSN is started. In case the search space is greater than or equal to 3, then the next step is to save the search space and initialize the Tabu search algorithm for determining the optimised node that can be selected as a cluster head. Clusters here are referred to as search space.

Step 7: After initialization of Tabu search algorithm, all the cluster heads saved in the search space are reached and checked one by one.

Step 8: After checking cluster heads the next step is the optimization of cluster head, if it is successful then the analysis of stability parameters of WSN is started otherwise the control is returned to step 6 for re-initialization of the Tabu search algorithm. This can be repeated till the optimised cluster head is not selected from within the search space greater than 3.

Step 9: Analysis of different parameters i.e., Cluster Head, Throughput, Dead Node and Alive Node, Energy, PDR is done.

In addition to this we, also present the pseudo code for the proposed optimised cluster head selection mechanism using ABC optimization algorithm as Algorithm 1 written below.

Tabu Search Mechanism

It is a deterministic metaheuristic approach based on local search. Tabu search carefully explores the neighbourhood of each solution. It uses a search procedure to iteratively move from one potential solution x to an improved solution x' in the neighbourhood of x until some stopping criterion is met. The solution admitted to the new neighbourhood $N^*(x)$ are determined through the use of memory structures which form a tabu list. in set F to bypass passing on particular block section and then obtain new function F', then evaluation is done to estimate the value of (F'.S(F)). After choosing the function F' with some rules, the implementation requires the minimization of maximum delay by clear up the resulting CDRFR problem. The process is on repetition until a stopping criterion is happen.

4. RESULTS AND DISCUSSION

4.1 INTRODUCTION

Parameters	Value
Number of Nodes	300
Protocol	LEACH
Topology	CLUSTER
Optimization	MO,ABC-TABU
AREA	300*300
simulation time	200 sec
Packetsize	512B
Transmission Range	20meter
CBR	500 KBPS
Traffic Source	CBR
Node speed	25 m/s
Rate	500 KBPS

This chapter describes the detailed result or the proposed work by using tables and graphs of the results. The performance evaluation of the proposed ABC_TABU LEACH is compared with TABU LEACH and with LEACH also. The comparison based on the number of rounds and the nodes in the cloud. The comparison is based of the following parameters:-

clusterheads

Dead Nodes

Throughput

Average residual Energy

5. RESULT ANALYSIS

5.1 Result Analysis

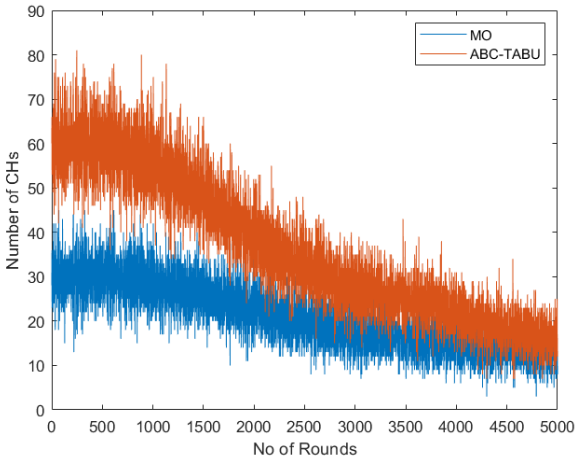

Figure 5.1 Number of cluster head in ABC_TABU LEACH and TABU LEACH

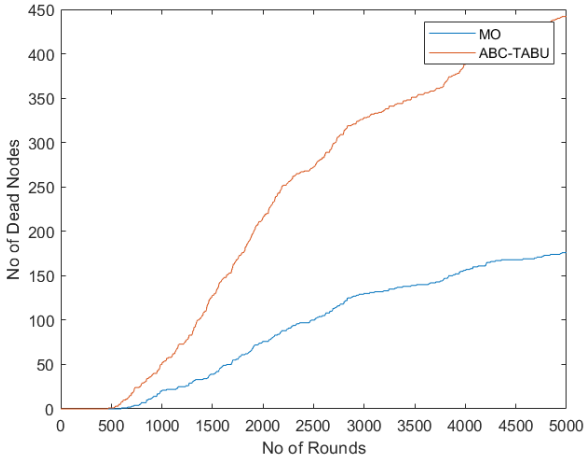

Figure 5.2 Number of dead Nodes in ABC_TABU LEACH and TABU LEACH

The above given Figure 5.2 represents the dead nodes in the number of rounds on the two algorithms ABC_TABU LEACH and TABU LEACH. The Blue line on the graph represents the ABC_TABU LEACH and red line represents the TABU LEACH nodes. The round starts from the 0 to 1000 and the minimum number of dead node is present in round 150 and changes according to the number of nodes changes. The graph curve concluded that the number of dead nodes in ABC_TABU LEACH is less than TABU.

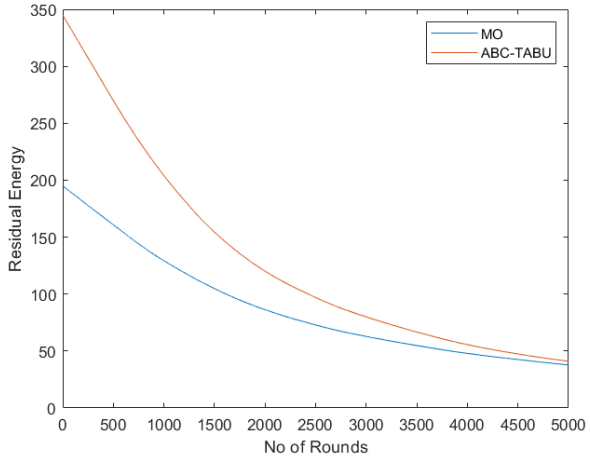

Figure 5.4 Average Residual Energy ABC_TABU LEACH and TABU LEACH

The above given Figure 5.4 represents the average residual energy in the number of rounds on the two algorithms ABC_TABU LEACH and TABU LEACH. The Blue line on the graph represents the ABC_TABU LEACH and red line represents the TABU LEACH nodes. The average residual energy of the ABCoptimization algorithm with LEACH is better than the existing TABU.

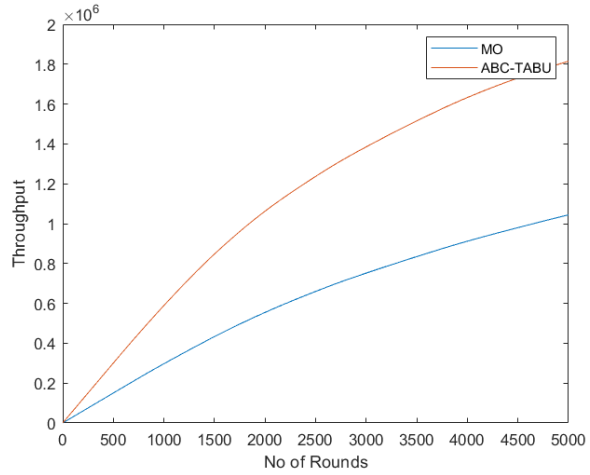

Figure 5.3 Throughput on ABC_TABU LEACH and TABU LEACH

The above given Figure 5.3 represents the throughput in the number of rounds on the two algorithms ABC_TABU LEACH and TABU LEACH. The Blue line on the graph represents the ABC_TABU LEACH and red line represents the TABU LEACH nodes. The throughput of the ABC optimization algorithm with LEACH is better than the existing TABU.

6. CONCLUSION

WSNhave gained a lot of attention is the last few years and used by the peoples in various applications and also in the military services. In WSN it is very challenging process to design a robust and scalable routing protocol which performs well at the time of data congestion on network. In the proposed work particle swarm optimization algorithm is used to provide the optimal result in the nodes of WSN. ABC_TABU work on the biological behavior of the swarms a provides effective solution. In this work ABC_TABU is used for selection of cluster heads according to their size. It works on the alive nodes, dead nodes and the energy consumption by the nodes. The results depict the ABC_TABU performs better than the existing approach TABU LEACH and LEACH in every scenario.

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