Energy Efficient Cluster-Based Routing Protocol over Wireless Sensor Network

Shubham Saxena[1], Anjana Nigam[2]
[1]M-tech Research Scholar, Department of Computer Science & Engineering
[2]Assistant Professor, Department of Computer Science & Engineering
Sagar Institute of Science & Technology, Bhopal

Abstract: Transferring data from source node to destination is the most important as well as tuff task in the wireless sensor network. The Major drawback for the any wireless sensor networks is the availability of the energy in nodes because of the small size of the batteries they use as source of power. Balancing the route of the data transfer is one of the techniques that can be used to minimized sensor nodes energy consumption during operation. In this paper gives a bird eye over routing protocol of sensor network that concentrate over energy efficient routing in other to longer survival of sensor network. Proposed methodology present a novel routing protocol for multipath energy efficient routing over sensor network that encapsulate advantage of two different predefine method in order to overcome their limitation. Proposed protocol tries to provide supplement support to lower energy node at heavy traffic by higher energy node from lower traffic of network. In this work outlier detection and the Linear Regression approach has been use as a hybrid approach to find the high energy node. This approach helps to enhance the network survival. The simulation results also provide the batter results as compare to previous approach. The technique was tested through simulations for different distributions of nodes. Under all the evaluated scenarios, the technique demonstrates excellent performance as compare to existing one.

Keywords: WSN, Sensor, Routing, Fuzzy C-Means, Linear Regression

I. INTRODUCTION

In recent years development in communication technology has allowed to the development of lightweight, intelligent, low cost sensor nodes that efficiently transfer data from one place to another place [1]. The sensor nodes of communication network have the ability to transfer data between other nodes and responsible to establish contact with the base station. A sensor node consists of sensing, processing, communication, transceiver and power units [2]. These sensors are used to collect messaging data, process, and communicate to other sensors in the wireless networks mainly, through radio frequency channel [3].

In many different applications wireless sensors networks (Wireless network) have been used such as monitoring movement of wild animals in the forest, battlefield surveillance, home security, earth movement detection, and healthcare applications [4]. Mobile sensor nodes can also be used in sensing ambient conditions such as light, sound, and temperature. Depending on the area of applications, sensor networks can be randomly distributed, for instance in military applications, sensor nodes can be randomly dropped from war-plane into the battlefield to monitor enemies' movement or manually placed.

A wireless infrastructure less network having static or dynamic topology is called the sensor network. The basic entity used here is called the sensor. This type of network meets Combine different types of nodes and gateways. Due to the mobility of the nodes in the network supports the dynamic feature. The sensor network can temporal establish instantly and its Example is shown in figure 1.

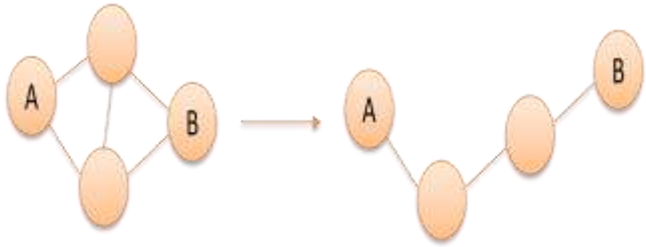

Figure 1: Sensor Network

In this scenario there is a source and destination node is available for communication. Wireless sensor network is a large number of static or mobile sensor nodes which form the wireless network using self organization and multi-hop method, its purpose is to collaborative detection, processing and transmitting the object monitoring information in areas where the network coverage is hard to reach [5].

Wireless sensor network routing protocols can be divided into flat routing and hierarchical routing protocol in the network structure. All sensor nodes in the flat routing protocol generally have the same function. However, the nodes in the hierarchical routing protocol usually play different roles. The high energy node in the routing protocol is used to process and send a message, while the low energy of the node is used to sense the target area information.

II. WIRELESS SENSOR NETWORK

Wireless Sensor Networks (WSN) has emerged as an important area for research and development. Though WSN is in its early stages, its impact is envisaged to be far reaching, from daily life, to remote monitoring of environment, habitat, agriculture, health care, automobiles, hazardous zones, disaster prone zones, defense applications to probing of planets. Moreover they can be used for monitoring as well as control. In fact, they form the basic constituent of ubiquitous sensing, communication, computing, and control.

A WSN can be defined as a network of devices, denoted as nodes, which can sense the environment and communicate the information gathered from the monitored field through wireless links. The data is forwarded, possibly via multiple hops, to a sink that can use it locally or is connected to other networks through a gateway. The nodes can be stationary or moving. They can be aware of their location or not. They can be homogeneous or not. It is a traditional single-sink WSN.

This single-sink scenario suffers from the lack of scalability: by increasing the number of nodes, the amount of data gathered by the sink increases and once its capacity is reached; the network size cannot be augmented. Moreover, for reasons related to MAC and routing aspects, network performance cannot be considered independent from the network size.

III. RELATED WORK

Wang et al. [9] Recent advances in micro manufacturing technology have enabled the development of low-cost, low-power, multifunctional sensor nodes for wireless communication. Diverse sensing applications have also become a reality as a result. These include environmental monitoring, intrusion detection, battlefield surveillance, and so on. In a wireless sensor network (WSN), how to conserve the limited power resources of sensors to extend the network lifetime of the WSN as long as possible while performing the sensing and sensed data reporting tasks, is the most critical issue in the network design. In a WSN, sensor nodes deliver sensed data back to the sink via multi-hopping.

The sensor nodes near the sink will generally consume more battery power than others; consequently, these nodes will quickly drain out their battery energy and shorten the network lifetime of the WSN. Sink relocation is an efficient network lifetime extension method, which avoids consuming too much battery energy for a specific group of sensor nodes. In this paper, we propose a moving strategy called energy-aware sink relocation (EASR) for mobile sinks in WSNs.

The proposed mechanism uses information related to the residual battery energy of sensor nodes to adaptively adjust the transmission range of sensor nodes and the relocating scheme for the sink. Some theoretical and numerical analyze are given to show that the EASR method can extend the network lifetime of the WSN significantly.

Castaño et al. [10] has considered the duty scheduling of sensor activities in wireless sensor networks to maximize the lifetime. We address full target coverage problems contemplating sensors used for sensing data and transmit it to the base station through multi-hop communication as well as sensors used only for communication purposes. Subsets of sensors (also called covers) are generated.

Those covers are able to satisfy the coverage requirements as well as the connection to the base station. Thus, maximum life-time can be obtained by identifying the optimal covers and allocate them an operation time. The problem is solved through a column generation approach decomposed in a master problem used to allocate the optimal time interval during which covers are used and in a pricing sub problem used to identify the covers leading to maximum lifetime.

Additionally, Branch-and-Cut based on Benders' decomposition and constraint programming approaches are used to solve the pricing sub problem. The approach is tested on randomly generated instances. The computational results demonstrate the efficiency of the proposed approach to solve the maximum network lifetime problem in wireless sensor networks with up to 500 sensors.

Halder, et Al. [11] identified that wireless sensor networks (WSNs) have been receiving significant attention due to their potential applications in environmental monitoring and surveillance domains. In WSNs, unbalanced energy consumption is an intrinsic problem and this can considerably decrease network lifetime. One primary way of mitigating uneven energy consumption is judicious deployment of sensor nodes so that the energy flow remains balanced throughout the network.

In this work, at first we analyze layered network architecture and find out the conditions that need to be satisfied for optimal deployment setting in order to achieve complete area coverage, energy balance and prolonged network lifetime. We also analyze two standard distribution functions to find out their suitability as node deployment function and found neither of the distribution functions ensures balanced energy consumption, thereby failing to prolong network lifetime.

Keeping the conditions of optimal node deployment setting in mind, and considering the reasons of unsuitability of the two standard distributions mentioned above, we identify Archimedes' spiral based on which a node deployment function is proposed. Furthermore, we show the proposed deployment function provides optimal deployment setting and derive the constraint for balanced energy consumption, thereby subsequent enhancement of network lifetime.

Exhaustive simulation is performed primarily to measure the extent of achieving our design goal of enhancing network lifetime while attaining energy balancing and maintaining coverage. We also measure the effect of placement errors on the performance of the scheme and show that even in presence of placement error the performance is comparable with the other competing schemes. Further, the simulation results show that our scheme does not compromise with other network performance metrics such as end-to-end delay and throughput while achieving the design goal.

Finally, all the results are compared with three competing schemes and the results confirm our scheme's supremacy in terms of both design performance metrics as well as network performance metrics.

Incebacak et al. [12] Contextual privacy in Wireless Sensor Networks (WSNs) is concerned with protecting contextual information such as whether, when, and where the data is collected. In this context, hiding the existence of a WSN from adversaries is a desirable feature. One way to mitigate the sensor nodes' delectability is by limiting the transmission power of the nodes (i.e., the network is operating in the stealth mode) so that adversaries cannot detect the existence of the WSN unless they are within the sensing range of the WSN.

Position dependent transmission power adjustment enables the network to maintain its level of stealth while allowing nodes farther from the network boundary to use higher transmission power levels. To mitigate the uneven energy dissipation characteristic, nodes that cannot dissipate their energies on communications reduce the amount of data they generate through computation so that the relay nodes convey less data.

Dynamic data compression/decompression strategies reduce the amount of data to be communicated, thus, they achieve better energy savings when compared to static compression/decompression of data in which the data is always compressed independently of the power transmission strategy. In this study, we investigate various data compression strategies to maximize the lifetime of WSNs employing contextual privacy measures through a novel mathematical programming framework.

Castaño et al. [13] addresses the maximum network lifetime problem in wireless sensor networks with connectivity and coverage constraints. In this problem, the purpose is to schedule the activity of a set of wireless sensors, keeping them connected while network lifetime is maximized. Two cases are considered. First, the full coverage of the targets is required, and second only a fraction of the targets has to be covered at any instant of time. An exact approach based on column generation and boosted by GRASP and VNS is proposed to address both of these problems.

Finally, a multiphase framework combining these two approaches is built by sequentially using these two heuristics at each iteration of the column generation algorithm. The results show that our proposals are able to tackle the problem efficiently and that combining the two heuristic approaches improves the results significantly.

Lee et al. [14] analyzed the lifetime of a wireless sensor network (WSN) is defined as the duration until any sensor node dies due to battery exhaustion. If the traffic load is not properly balanced, the batteries of some sensor nodes may be depleted quickly, and the lifetime of the WSN will be shortened. While many energy-efficient routing schemes have been proposed for WSNs, they focus on maximizing the WSN lifetime.

In this paper, we propose a scheme that satisfies a given ‘target’ lifetime. Because energy consumption depends on traffic volume, the target lifetime cannot be guaranteed through energy-efficient routing alone. We take an approach that jointly optimizes the sensing rate (i.e., controlling the sensor-traffic generation or duty cycle) and route selection. Satisfying the target lifetime while maximizing the sensing rate is a NP-hard problem.

Our scheme is based on a simple Linear Programming (LP) model and clever heuristics are applied to compute a near-optimal result from the LP solution. We prove that the proposed scheme guarantees a 1/2-approximation to the optimal solution in the worst case. The simulation results indicate that the proposed scheme achieves near-optimality in various network configurations.

Zhang et al. [15] motivated by recent developments in wireless sensor networks (WSNs), we present several efficient clustering algorithms for maximizing the lifetime of WSNs, i.e., the duration till a certain percentage of the nodes die. Specifically, an optimization algorithm is proposed for maximizing the lifetime of a single-cluster network, followed by an extension to handle multi-cluster networks. Then we study the joint problem of prolonging network lifetime by introducing energy-harvesting (EH) nodes.

An algorithm is proposed for maximizing the network lifetime where EH nodes serve as dedicated relay nodes for cluster heads (CHs). Theoretical analysis and extensive simulation results show that the proposed algorithms can achieve optimal or suboptimal solutions efficiently, and therefore help provide useful benchmarks for various centralized and distributed clustering scheme designs.

Xenakis, et Al. [16] explored the wireless Sensor Network (WSN) the sensed data must be gathered and transmitted to a base station where it is further processed by end users. Since that kind of network consists of low-power nodes with limited battery power, power efficient methods must be applied for node communication and data gathering in order to achieve long network lifetimes. In such networks where in a round of communication many sensor nodes have data to send to a base station, it is very important to minimize the total energy consumed by the system so that the total network lifetime is maximized.

The lifetime of such sensor network is the time until base station can receive data from all sensors in the network. In this work1, besides the conventional protocol of direct transmission or the use of dynamic routing protocols proposed in literature that potentially aggregates data, we propose an algorithm based on static routing among sensor nodes with unequal energy distribution in order to extend network lifetime and find a near-optimal node energy charge scheme that leads to both node and network lifetime prolongation.

Our simulation results show that our algorithm achieves longer network lifetimes mainly because the final energy charge of each node is not uniform, while each node is free from maintaining complex route information and thus less infrastructure communication is needed.

Nok Hang Mak et al. [17] observe that the wireless sensor networks are known to be highly energy-constrained and each network’s lifetime has a strong dependence on the nodes’ battery capacity. As such, the network lifetime has been a critical concern in WSN research. While numerous energy-efficient protocols have been proposed to prolong the network lifetime, various definitions of network lifetime have also been used for the different scenarios and protocols.

The lifetime of a sensor network is most commonly defined as the time to the first sensor node failure seemingly over-pessimistic in many envisaged deployment scenarios. While other definitions exist, there has not been any consensus on which quantitative lifetime definition is most useful. In this paper, the author has aimed to provide as objectively as possible, a comparative study of WSN protocols based on various network lifetime definitions. They also discuss the implications of these metrics and their applicability in evaluating the effectiveness of WSN data delivery schemes.

Xiong, et al. [18] explored the wireless sensor network as often deployed for environment monitoring and event inspection. Among these applications, the sink of the network usually requires the data generated on each sensor node periodically, and such a network is called a data-gathering sensor network. In each round of the data gathering process, a sensor node sends its reading via a single-hop or multi-hop path to the sink. Because the sensor nodes are usually battery-powered with limited energy, efficient routing strategy is required to reduce and balance the energy consumption of the sensor nodes in data transmission.

This paper studies the problem of maximizing the lifetime of a data-gathering sensor network, which is defined as the number of rounds until the first node depletes its energy. The author has proved that the problem is NP-Complete, and then formulates it as an integer program to get close to optimality. The author has further proposed a polynomial-time and provably near optimal algorithm to reduce the tremendous computation and storage cost of the integer program. Finally, they evaluate the efficiency of our algorithms by extensive experiments.

Adilah and Latiff [19] identified the major source of a sensor node failure is battery exhaustion and replacing this energy source in the field is usually not practical. Therefore, the use of energy efficient infrastructure, such as repositioning the base station in a clustered wireless sensor network, is able to prolong the lifetime of the network and improve the overall network data. In this paper, we proposed an energy-efficient protocol for the repositioning of mobile base station using particle swarm optimization (PSO) in wireless sensor networks. Simulation results demonstrate that the proposed protocol can improve the network lifetime, data delivery and energy consumption compared to existing energy-efficient protocols developed for this network.

Yueqing [20] explored the topology of the structure is the first step in the design and construction of wireless sensor networks. A desirable topology can extend the lifetime of the entire network. This paper focuses on the complexity of the structure of the topology of wireless sensor network and analyze their complex characteristics in terms of the theory of network science. Wherever wireless sensor network is scanned for.

The results indicate that for the mesh network, the node degree is uniformly distributed, have comparatively smaller mean path length and greater coefficient cluster. Then compare it to another network, the wireless sensor network is the network regularly or complete random network. It lies between the random network and small world network and has a certain property which is similar to network small world.

To reduce the hops in the network, in this paper the construction of a small world network of wireless sensors by adding shortcuts to the network, which is subject to restrictions of distance between individual nodes. Simulation results for these short cues shoes greatly reduce the average length of trajectory. This is beneficial for improving the efficiency of energy use of the network.

Krishna [21] Wireless sensor networks have been developed and applied to industrial, commercial, defence and civil sector applications. Energy is the main obstacle in sensor networks. Techniques energy management increases the life cycle of the sensor array and to improve production efficiency. Approaches to multi-hop communication and clustering are used to save node energy in sensor networks. Protocols energy to minimize the participation of current sensor nodes with less energy and select the optimal path to the threshold energy.

In sensor networks, cluster heads (CHS) to collect data from sensor nodes and sent to the neighbour CHS and finally to the base station (BS). CHS help save energy node. Cluster management techniques designed to minimize the number of clusters, the density of the cluster and the cluster energy consumption. In this paper, we propose Energy organized aware clustering protocol (SECC) for sensor networks wireless sensor network group based energy node and groups of remote nodes. If the energy of the node is less than the threshold value, SECC self-organized clusters of forms and reorganize the sensor array.

The nodes having less than the threshold value energy attributes are removed from the cluster network to maintain efficient energy sensors. Energy management in clusters SECC node function parameters (such as remote node, power node, the node density) and cluster parameters (such as cluster density, sensor nodes per group) . Performance analysis and simulation results are given with variations in the number of clusters, the energy levels and the distance from the node.

Boniewicz [22] algorithms proposed in the method of the wireless sensor network are compared. Energy consumption is very important for self-powered radio nodes. But some energy applications balance is more important. Networks of wireless sensors used in large areas such as farmland or stores consist of hundreds of nodes. In the conventional method of routing is directed to transmit a short time and low energy consumption. But consumption of unbalanced energy can often cause unpredictable failures due to lack of energy in the nodes of frequent use.

Energy balance to avoid this dynamic behaviour by skipping nodes used. The document discloses examples of algorithms that may be used in the method of the wireless sensor network. The aim of this method is the extension of the network via a data path selection to minimize the dispersion of energy in the network nodes.

It is seen that most of the previous approaches for chose alternate path directly when any node shout down that dropped performance and have relative higher complexity. As the mobile nodes operate on the limited power of battery therefore it becomes very necessary to develop techniques which can successfully maintaining lesser complexity. The objective of this dissertation is to develop a new approach which can successfully maintain the rout with lesser battery power in order to long survival of Sensor network.

A large number of businesses must find another way when it is exempt from a node in the network. Because of this attack on the overall performance of the network will also reduce in relation to the complexity of the routing protocol. The purpose of this letter is to develop a methodology to improve the network to survive for as long as possible.

IV. Proposed Routing Procedure

The proposed solution is going to provide supplement support the high junction lower energy node with lower junction high energy node. Proposed method used liner regression for deciding which high energy node provides supplement support to high junction node without break its own connectivity. The proposed methodology as shown in figure 2 uses to select node from low traffic area having middle resident energy limit to provide supplement support low energy node at high traffic zone.

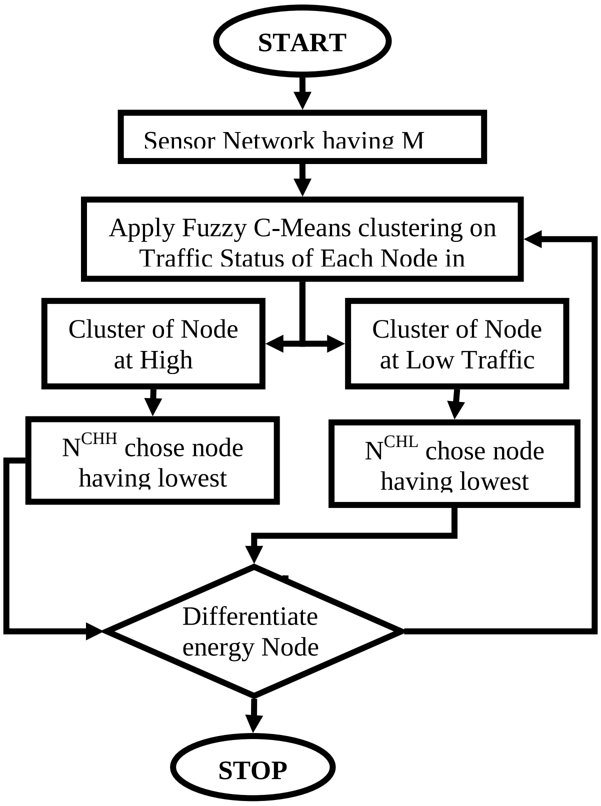

Figure 2: Proposed Methodologies for Sensor Network Life Saving Routing Protocol

The proposed algorithm initially assumes power limit knot low-energy environment and a resident residing knot. If a node in the network degrades the minimum energy for low power node, and residents knot broadcast replace its own package. If a node neighbors have more energy than the average resident and reduce reside in low traffic area traffic select to provide additional support.

The proposed solution will work for all the nodes exist in the network. Here traffic of network will check at the time duration. For the M sensor node algorithm has been trying to find the lower energy node. Here we get the high energy node. Now the linear regression approach has been apply in order to swap the nodes. The swapping has been take place between lower energy node and higher energy node.

V. PROPOSED ALGORITHM FOR ROUTING PROTOCOL

The proposed solution is to provide more support for high energy intersection knot less with low and high energy knot intersection. The proposed method uses a linear regression to decide which high-energy knot provides additional support to the intersection of high knot without breaking its connection. In the proposed methodology as shown in figure 2 is used to determine the knot of traffic with low energy limit residents of medium zone to provide support supplement low power consumption node to the high traffic area.

The proposed algorithm initially assumes the power limit knot low-energy environment and resident residing knots. If a node in the network degrades the minimum energy for low power node, and residents knot broadcast replace its own package. If a node neighbors have more energy than the average resident and reduce reside in low traffic area traffic select to provide additional support.

Assumption

1. $Sensor_{network} = Sensor\ network\ having\ M\ sensor\ Node;$
2. $Node = Sensor\ Node;$
3. $SN_{HT} = Sensor\ Node\ at\ high\ traffic;$
4. $SN_{LT} = Sensor\ Node\ at\ Low\ traffic\ ;$
5. $S_T = Simulation\ Time\ ;$

Algorithm( )
For (i=1 to i<=M)
{
  Check traffic status of each node M (i) in network
  If (Node M(i) is in Node HT)
  Then
    Node M (i) include in S nht
  Else
    Node M (i) include in S nlt
}
For (i=1 to i<=number of node in Snht)
{
 If(energy (Snht(i) < Lower limit))
 {
  1. *Apply linear regression over Snlt and search node for swap*
  2. *Swap the node from Snht to Snlt*
 }}

VI. SIMULATION DETAIL & RESULT ANALYSIS

Even though the performance evaluation/analysis of ad hoc routing protocols is usually measured in homogeneous network, this evaluation is not much effective in the real applications where nodes have different capabilities. To study the efficiency and the effectiveness of routing protocols in heterogeneous ad hoc networks, NS-2 simulator is used to construct the simulation. The details of the simulation scenarios and performance metrics are illustrated in table 1.

Table 1: Simulation Parameters

Parameters	Values	
Number of Nodes	Vary from 50 to 250	
Area	50	600*300
	100	600*300
	150-250	1000*800
Traffic	CBR	
Simulation Duration	100 Mili Seconds	
Packet Transmission Rate	1024 kbps	
Carrier sense threshold Used In Normal Nodes	200 Meter	

Packet Delivery Ratio: Packet delivery ratio of total number of packets successfully delivered during data transmission to total number of packet send. For any ideal routing protocol it is required that it has higher Packet delivery ratio, whereas existing approach by using PF-MHR(Potential Field based mini-mum hops routing) Based On Potential Field have lower packet delivery ratio as compare to proposed methodology by using LR(Linear regression)- based on Potential Field.

$$\text{Packet delivery ratio} = \frac{\text{No of data packet delivered to distination}}{\text{number of packet generated}}$$

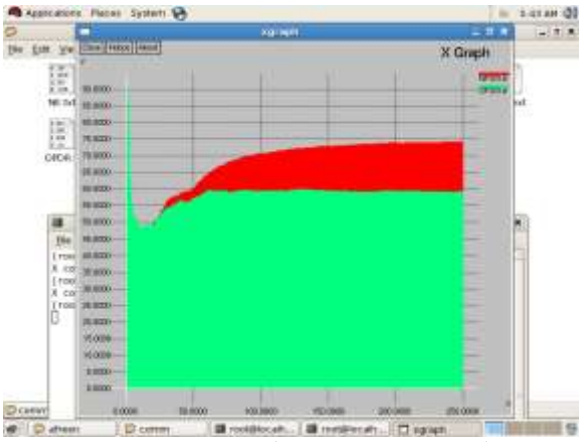

Figure 3: Comparative Analyses of packet delivery ratio of Proposed and Existing Approach

Routing Load: - Routing load is the overhead required to search route from source to destination and establish an end to end connection from source to destination. For any ideal routing protocol it is required that it has lower routing load, whereas existing approach by using PF-MHR Based On Potential Field have required higher control packet as compare to proposed methodology by using LR- Based On Potential Field.

$$\text{Routing Load} = \frac{\text{No. of Control Packet Send during Comm.}}{\text{number of packet generated}}$$

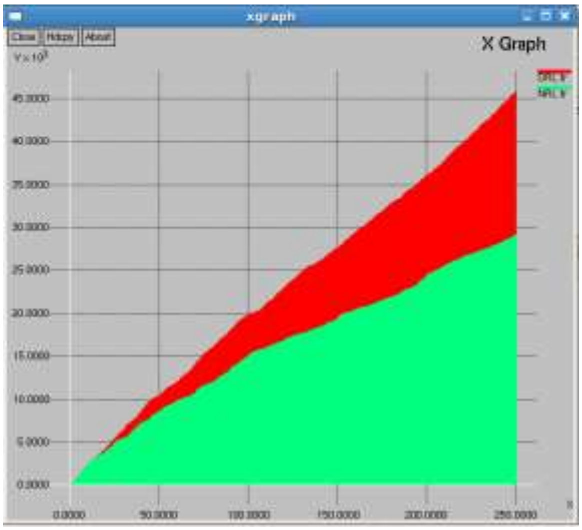

Figure 4: Comparative Analysis of Routing Load of Proposed and Existing Approach

Energy Consumption by Node: - Energy consumption means battery power used by any node for successful transmission. Higher energy consumption degrades the survival of network. And lower energy consumption maintains longer survival of network. For any ideal conduction network need longer survival. Using this protocol the retransmission will be reduced where existing methods are only able to minimized redundant path. **E**xisting approach by using PF-MHR Based On Potential Field have required higher battery power consumption as compare to proposed methodology by using LR- Based On Potential Field **.**

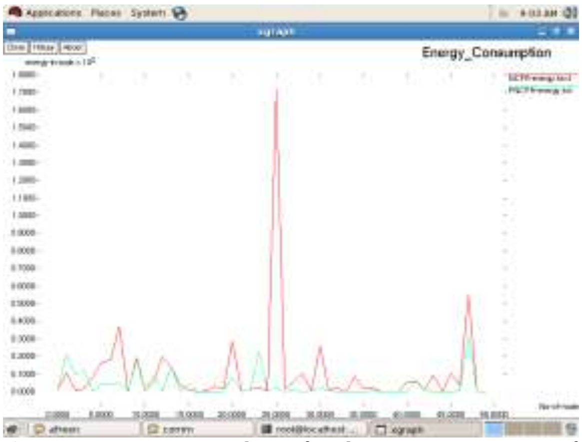

Figure 5: Comparative Analysis of Node Energy Consumption of Proposed and Existing Approach

Throughput: The fraction of the channel capacity for effective transmission (packets successfully delivered to the destination data) is given and is defined as the total number of packets received by the destination. It is in effect a measure of the efficiency of a routing protocol. In any sensor network it is required to have higher throughput i.e. need to increase rate of successful packet transmission.

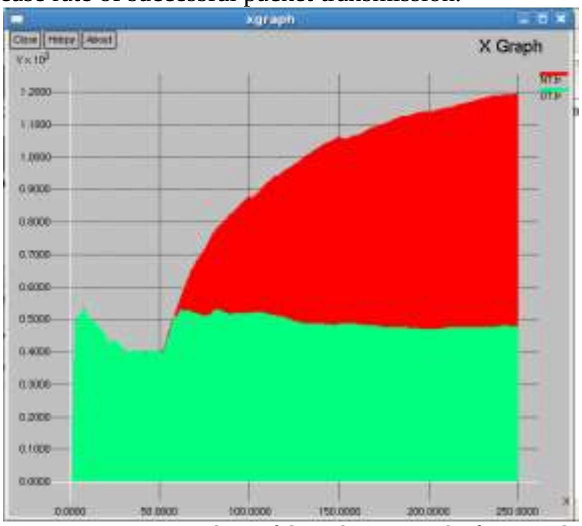

Figure 6: Comparative Analysis of throughput network of Proposed and Existing Approach

VII. Conclusion

This dissertation a novel secure location added data transfer protocol for multipath energy efficient routing over sensor network is presented. This method encapsulate advantage of two different predefine method in order to overcome their limitation. First swam intelligence and second one is bi partite graph. Proposed protocol tries to provide supplement support to lower energy node at heavy traffic by higher energy node from lower traffic of network. In order to enhance the reliability using redundant paths in the network, it is suggested to have a maximum number of paths between the source and the destination. It is necessary to have a minimum number of nodes in each redundant path.

Network reliability is increased in networks multipath disjoint nodes, where each node disjoint path has a maximum number of redundant paths and the minimum number of nodes in each redundant path. In the multi-path network node disjoint, the reliability is very high the performance of proposed technique is depending upon network density and network traffic.

In future, this work can even be increased to check on different protocols like DSDV or DSR. These works are often increased in future to produce a dynamic interface to alter the Greek keys such that in order that network are often safeguarded against the human errors.

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