

# ANT COLONY OPTIMIZATION FOR IMPROVING NETWORK LIFETIME IN WIRELESS SENSOR NETWORKS

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**ABSTRACT** Wireless sensor networks is very important field in today's technology and one may concern about the life time of sensors as they have no facility to change the battery of those sensors inside the field. Wireless Sensor Networks are prone to node failure due to power loss. In order to provide reliable service through the network, the network should be self-adjusting and must have adaptable properties as required from time to time. Here in this research we have proposed a new algorithm which is capable of not only to do optimize routing even with that it has the benefit to overcome through pits creating problem around the sink. We have used the Energy Efficient Shortest Path Routing algorithm for routing and multi-hop network to communicate every node with sink and have used Ant colony optimization to determine new position for a sink, so that network will communicate without any problem which generally occurred due to dead nodes around the sink. The performance of our proposed algorithm has been tested on static and mobile sink scenarios with varying speed, and compared with other state-of-the-art routing algorithms in WSN. In this research, we have investigated the impact of sink mobility on network lifetime. In a typical WSN, all the data generated in the network are routed to a static sink. Nodes near the sink tend to deplete faster in their energy which might cause holes in the network thus limiting the network lifetime. With the introduction of mobile sink, the nodes around the sink always changes, thus balancing the energy consumption in the network and improving the network lifetime. We have simulated four routing algorithms in two scenarios; static sink and mobile sink. It has been observed from the results, that the network lifetime has been improved by the proposed algorithm in comparison to other algorithms.

**Keywords:- WSN, Sink, Network, routing, Hops etc.**

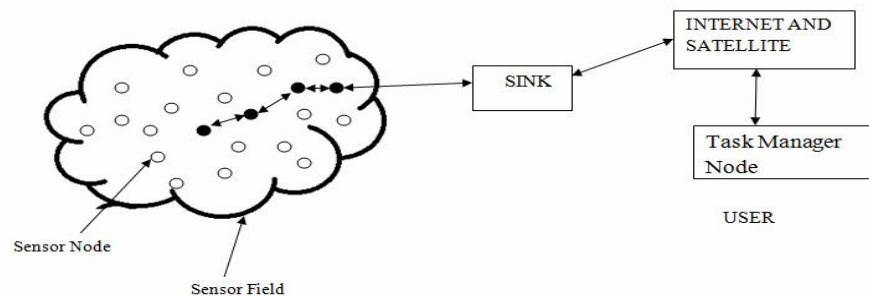
## INTRODUCTION

Wireless communication and networking are becoming very predominant due to their flexibility and ease of deployment. Particularly, sensor networks that involve large numbers of small-sized sensor nodes equipped with sensors and radio for wireless operation have found applications in several commercial and industrial areas [I.F.Akyildiz, W.Su, Y.Sankarasubramaniam and E.Cayirici, 2002]. Sensors link the physical world with the

digital world by capturing and revealing real-world phenomena and converting these into a form that can be processed, stored, and acted upon. Integrated into numerous devices, machines, and environments, sensors provide tremendous societal benefits. They can help to avoid catastrophic infrastructure failures, conserve precious natural resources, increase productivity, enhance security and enable new applications.

### 1.1 Wireless Sensor Networks

Wireless Sensor Networks is a collection of massive number of small, inexpensive, self-powered devices that are capable of sensing, computing and communicating. Recent advances in micro-electro-mechanical systems (MEMS) technology have enabled the development of low-cost, low-power, multifunctional sensor nodes that are small in size and communicate untethered in short distances. Smart sensor nodes are low power devices equipped with one or more sensors, a processor, memory, a power supply, a radio and an actuator. A variety of mechanical, thermal, biological, chemical, optical and magnetic sensors may be attached to the sensor node to measure properties of the environment. These sensor nodes are densely deployed either inside the phenomena or very close to it. The nodes are deployed randomly in the inaccessible terrain or disaster relief operations. Any event change sensed is communicated to the base station with the multihop communication between nodes. As depicted in Fig. 1.1, whenever any event change occurs the sensor notifies the sensed change to the sink with multihop communication [J.Yick, B.Mukherjee and Dipak Ghosal,2008]. This event notification is further send to the controlling site to take appropriate action accordingly. The user is connected to the application field through internet and takes appropriate decisions to handle the emergency situations according to the application.



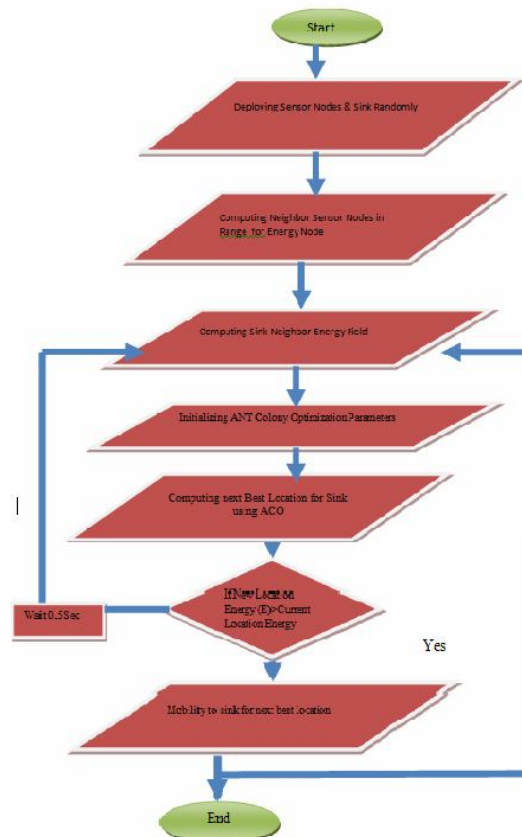
#### Architecture of sensor network

Apart from the sensing sensors, the user can also inject queries into the network through sink to know the current status of the area being monitored. The capabilities of sensor nodes in a WSN can vary widely, that is, simple sensor nodes may monitor a single physical phenomenon, while more complex devices may combine many different sensing techniques (e.g., acoustic, optical, magnetic). The different sensing nodes can be deployed depending on the phenomena to be monitored. The deployment of these nodes can be done either randomly or in a preplanned manner. While simple sensors may only collect and communicate information about the observed environment, more powerful devices (i.e., devices with large processing, energy, and storage capacities) may also perform extensive processing and aggregation functions. Such devices often assume additional responsibilities in a WSN for example; they may form communication backbones that can be used by other

resource-constrained sensor devices to reach the base station. Some of the sensor nodes can be send to sleep mode to avoid sensing and communication of redundant information. The sampling rate of the sensing devices can also be adjusted to improve energy efficiency of the WSN. All these factors together contribute to the longevity and efficiency of the deployed application.

## METHODOLOGY

In this work, to experimentally analyze the performance of purposed algorithm we first randomly deployed the sensor nodes in the region of area 200\*200m. We also randomly deployed the sink in the region of interest. After deploying the sink, we compute the energy field of sink at the present location .This has been done by calculating the energy of each node in the range of sink. Now after that we use ACO to compute the next best location for the sink.



### Proposed methodology for sink mobility

We initialize the ACO parameters and send the ants compute the energy field within their range and give us the next best location for the sink .Now we check that whether the new location is better than the current location .if yes then sink moves to the next best location and advertises its position to the neighbors By doing like this sink always remains at its best position and the energy of each and every node is balanced because each sensor node has

to transfer less data for other nodes and in this scenario maximum nodes should be in range of sink and by doing like this no specific nodes should get consumed which results in increase in lifetime of the network and also with sink at its best position , packets has to traverse less number of hops to reach the sink, which results in less energy consumption in this algorithm.

### Simulation parameters

Parameters	Values
Sensor Field Region	200*200
Number Of Nodes	9
Number Of Sinks	1
Query Packet Size	100 Bits
Data Packet Size	1024 Bits
Bit Rate	250 kbps
Carrier Frequency	2.5Ghz
Initial Energy	30 joules
Gain of Transmitter	1
Gain of Receiver	1
Modulation	Dpsk
Simulation Time	100 sec

The simulation parameters are taken in accordance with the designed network scenario and used energy model. The number of sensors nodes taken is 9 and sink is randomly deployed in area of 200\*200m. The number of nodes in each cell can be varied depending upon the application for which sensor nodes are deployed. The whole region is assumed to be divided into four quadrants. The Query packet size and Data packet size are taken to be 100 bits and 1024 bits. The simulation time can be varied to study the effect of the proposed scheme under different scenarios as per the requirements. In proposed work, the whole results are obtained by taking 100 seconds simulation time.

## RESULTS AND DISCUSSION

The proposed algorithm is evaluated under different scenarios to check their efficiency in the WSN. The various factors that influence the design of WSN are evaluated and analyzed to study their impact on the desired results. This chapter includes the performance evaluation parameters, various factors that affect performance and the obtained results in detail.

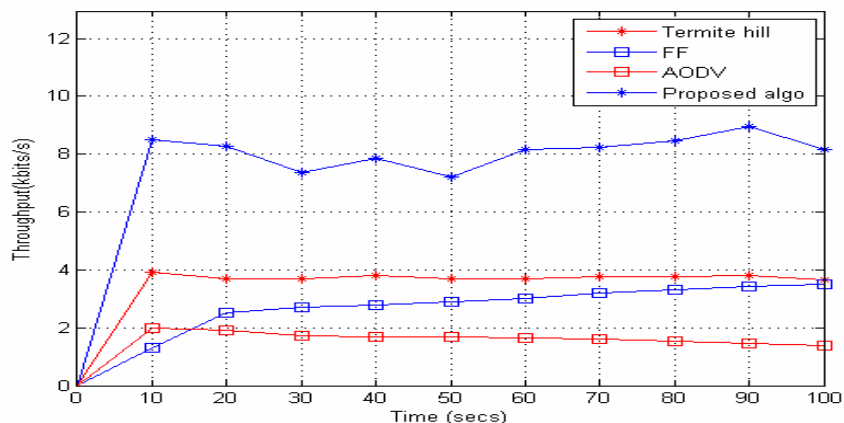
### Performance Evaluation Parameters

The proposed work needs to be evaluated against various parameters to measure its performance. Following are the parameters:

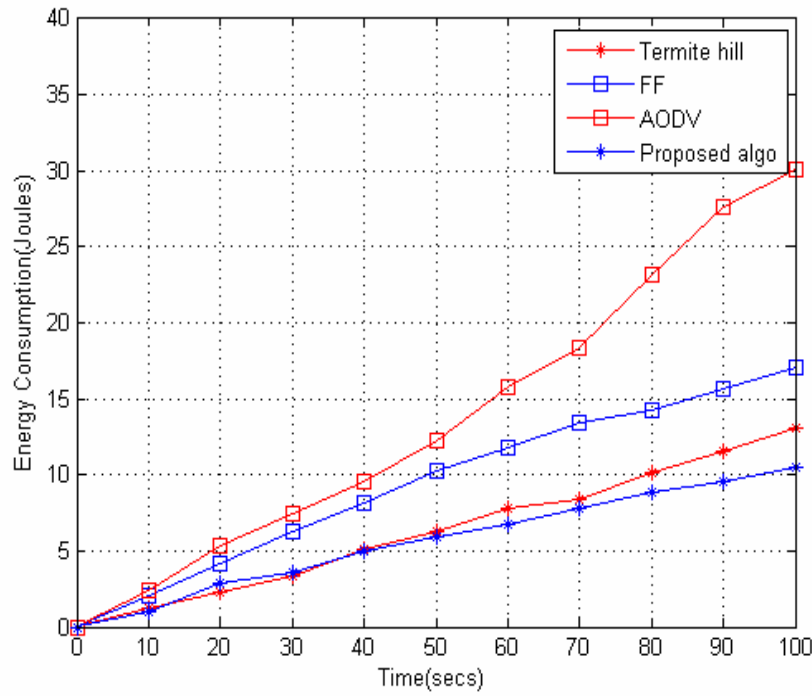
- 1) Energy Consumption: Energy Consumption of the entire network is the main performance evaluation parameter. The overall energy consumption of network includes the energy consumed by all the nodes in *sending and transmitting the data*.
- 2) Throughput: Throughput tells the average rate of successful packets delivered over the network. It is measured in data packets per second.
- 3) Lifetime: Network lifetime parameter evaluates the efficiency of the proposed Energy Aware Shortest Path Routing Algorithm. The network lifetime is computed by considering the time when first node of the network dies out. It is the difference of total energy of the network and the summation of average used energy of nodes and their energy deviation.
- 4) Energy Utilization Efficiency: It is a measure of the ratio of total packet delivered at the destination to the total energy consumed by the network's sensor nodes (Kbits/Joules).

### PERFORMANCE EVALUATION IN STATIC SINK CASE

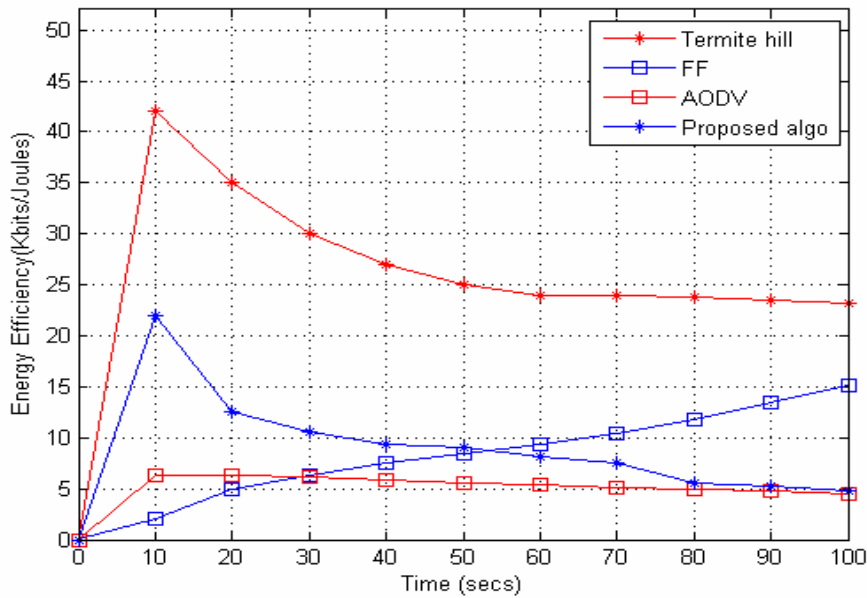
First, we evaluate the performance of purposed algorithm and compare with other routing protocols with static sink. In this scenario, we assume sink as static. In our simulation results as reported in Fig.4.1, shows the performance in term of network throughput energy consumption and energy utilization efficiency of the respective algorithms with different simulation time. In term of successful packet delivery per unit time, it was observed that our purposed algorithm has it maximum throughput .It maintains almost that value till the end of the simulation period. In the proposed algorithm energy consumption is low but in static sink case the nodes near the sink gets depletes very fast results in lesser network lifetime. In static sink case energy consumption is also less than other algorithms because of energy efficient shortest distance algorithm. Energy efficiency is bit lower in proposed algorithm than termite hill protocol but it is better than other protocols.



Throughput vs Time in Static Sink Case



**Energy Consumption vs Time in Static Sink Case**



**Energy Efficiency vs Time in Static Sink Case**

**PERFORMANCE EVALUATION UNDER MOBILE SINK CASE**

We evaluate the performance of purposed algorithm in case of mobile sink and compare with other routing protocols with mobile sink. In this scenario, we assumed our sinks Mobile.



In our simulation results as reported in Fig., shows the performance in term of network throughput, energy consumption, and energy utilization efficiency of the respective algorithms with different simulation time. In term of successful packet delivery per unit time, it was observed that our purposed algorithm has its maximum throughput at all the speeds sits than other routing algorithm. In Our proposed algorithm Energy Consumption is not increased with increase in speed as in static sink case energy consumption is increased with simulation Time.

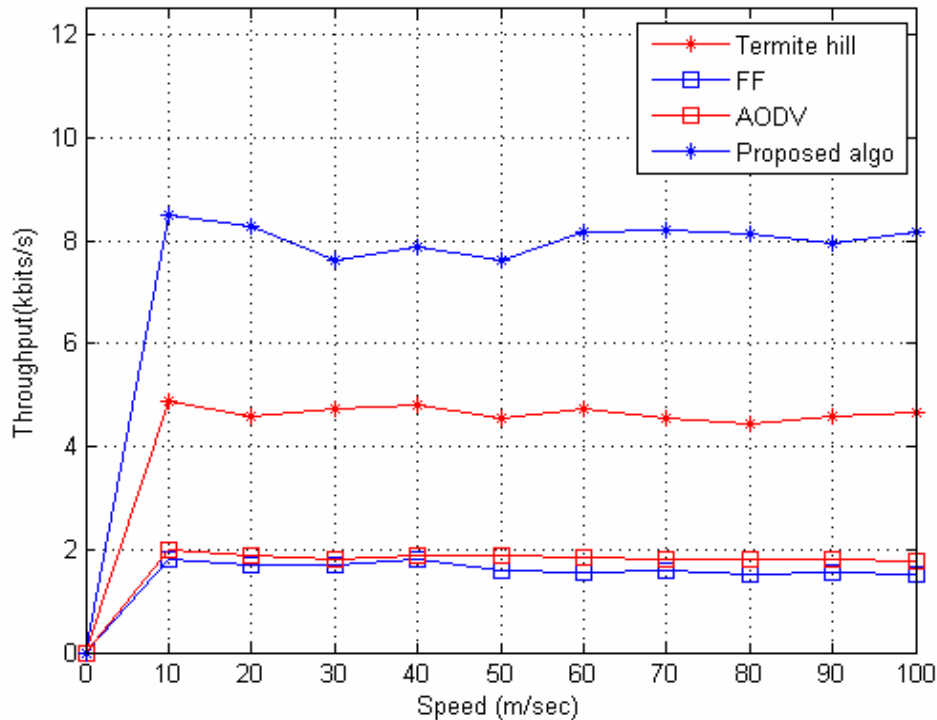


Fig. Throughput v/s Speed in case of Mobile Sink

This fig. shows that our proposed algorithm has higher throughput at different speeds than the existing termite-hill algorithm. Our proposed algorithm has higher throughput than the existing algorithm because in this case sink acquires the best position using ACO and it remains in this position until the next best location is searched. In this case maximum nodes are in reach of sink and packets have to traverse a lesser path to reach the sink.

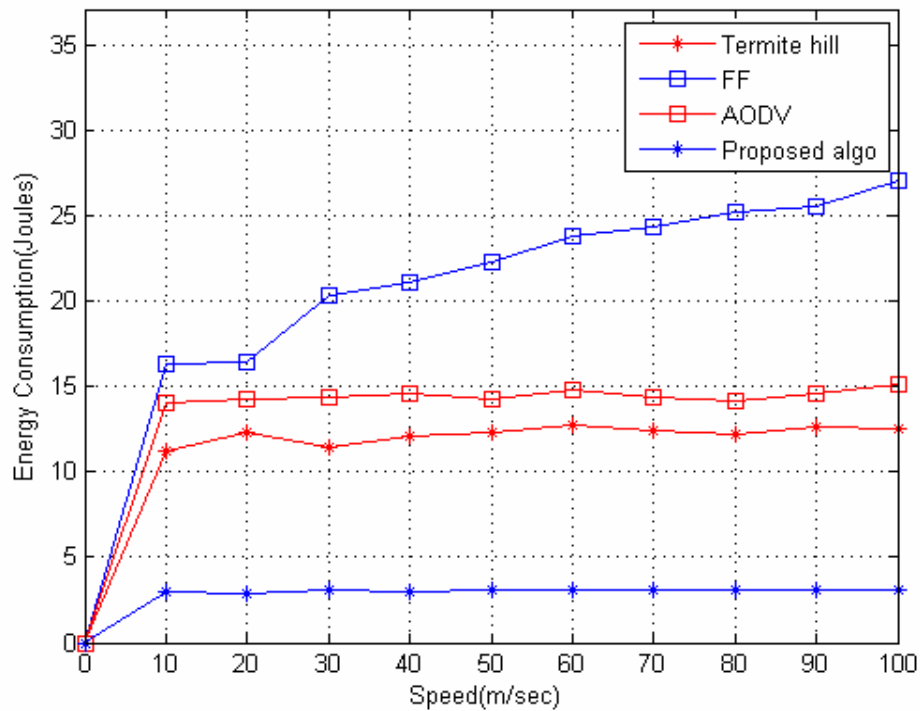


Fig. Energy Consumption v/s Speed in case of Mobile Sink

The fig. shows that our proposed algorithm has very less Energy Consumption at different speeds than the existing termite-hill algorithm. Our proposed algorithm has less energy consumption than the existing algorithm because most of the energy is consumed in transferring the packets to another nodes than the actual work but in this case with sink acquires the best position using ACO, maximum nodes are in reach of sink and packet have to traverse less path from source to sink. Due to this our proposed algorithms have less energy Consumption. Moreover energy consumption of proposed algorithm is not increased with the speed as it increased with increase in simulation time.



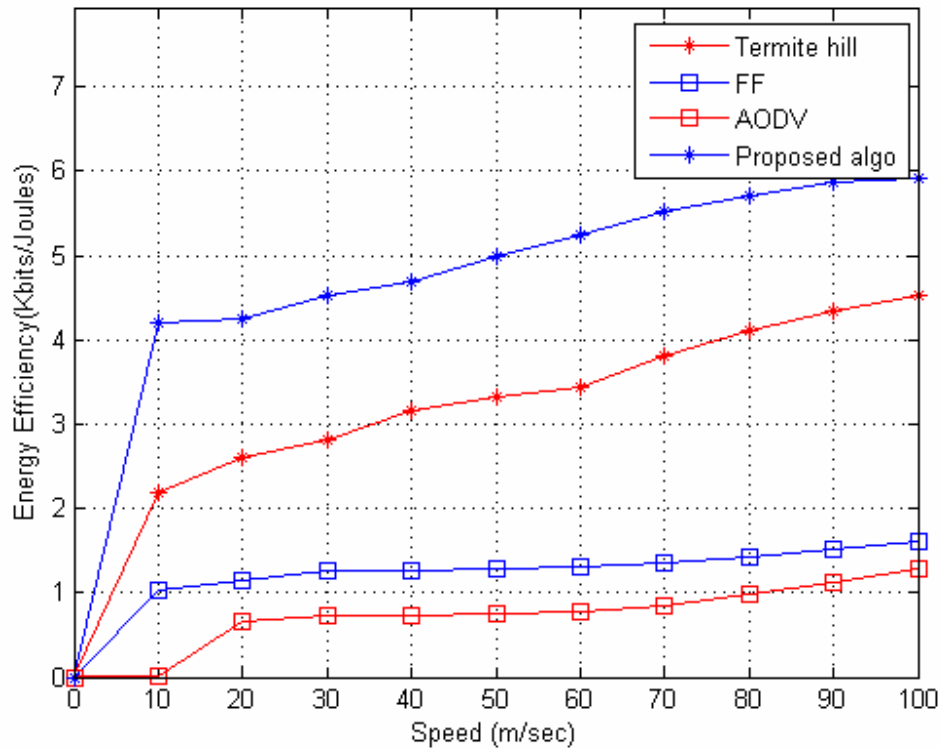


Fig. Energy Efficiency v/s Speed in case of Mobile Sink

This fig. shows that our proposed algorithm has higher energy efficiency at different speeds than the existing termite-hill algorithm. Our proposed algorithm has higher energy efficiency than the existing algorithm because in this case sink acquires the best position using ACO and it remains in this position until the next best location is searched. In this case, maximum nodes are in reach of sink and packets have to traverse fewer paths from source to sink.

### IMPACT OF SINK MOBILITY ON NETWORK LIFETIME

To further test the performance of the algorithm in mobility scenarios, we compared each of the protocols with itself for the static and mobility scenario to test the reliability of the network with mobile sink as seen in Figure. The performance of the entire algorithms in terms of the number of packets delivered to the sink with time dropped drastically. Though, it is only our proposed algorithm that was able to deliver as high as it does in static scenario even though, it increases the network lifetime in mobile sink scenario as can be seen in Summary Table below.

## Summary Table

Protocol	Static Lifetime	Mobile Lifetime	Difference
Proposed Algo	98.1548	99.2543	1.09
AODV	95.6783	98.1234	2.45
FF	98.0678	98.1234	0.06
Termite hill	98.3418	98.8656	0.51

## CONCLUSIONS AND FUTURE WORK

Network Lifetime is the main issue in WSN .We can enhance lifetime of the WSN only when the load is equally distributed in the network so that all the nodes consumes power equally and network becomes operational as long as possible. This thesis, investigate the impact of sink mobility and dynamic sink on network performance in a WSN using static, dynamic and mobility scenario of the network. Through the analysis, it was seen that the performance of the routing protocols in terms of energy utilization efficiency, network reliability, and network lifetime had a strong correlation between sink mobility, dynamic sink and simulation time This thesis exploits following engineering efforts to make a highly efficient Wireless sensor network:

- ❖ Energy consumption is decreased due to the energy efficient shortest path routing algorithm.
- ❖ The Throughput of our proposed algorithm is greater than Termite-hill, AODV and FF algorithm in mobile sink case.
- ❖ Energy efficiency of the proposed algorithm is also increased as compared to other algorithms
- ❖ Network Lifetime of WSN is greatly increased by the proposed algorithm as compared to other algorithms.

## SCOPE FOR FUTURE WORK

As the research work presented in this thesis has been tested in the simulation environment, so the applicability of the proposed algorithm on the real Wireless Sensor network needs to be checked.

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