Route Optimization & Increasing Energy Efficiency of WSN

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Abstract—The main motive of this research is to study route optimization using concept of Travelling Salesman Problem with Neighborhoods (TSPN) and to detect sensor data anomalies or irregularities in Wireless Sensor Networks. Detection of sensor data irregularities is useful for practical applications because the patterns found can be used for both system performance tuning and decision making in applications. For example, irregularities in sensory data are of interest of monitoring applications. The communication cost can be reduced if only normal sensory values, as opposed to all values, are transmitted. In addition, for this kind of applications, the energy efficiency of wsn is saved by sending packets without anomalies, as opposed to all values, need to be transmitted.

I. Introduction

A. *Wireless Sensor Networks*

A Wireless sensor network [1] is composed of tens to thousands of sensor nodes which are densely deployed in a sensor field and have the capability to collect data and route data back to base station. Wireless sensor Networks used in variety of applications, such
as health monitoring, scientific data collection, environmental monitoring, and military operations detecting like tracking troops, tanks on a battlefield, measuring traffic flow etc.Most wireless sensor networks consist of a large number of static, low-power, short-lived, and unreliable sensors.The experimental results confirm that the mobile robots successfully achieved their assigned tasks.

The robot routing problem involves generating a path along which the mobile robot can retrieve all data from all sensors while minimizing overall travel costs (distance).Generally, the robot routing problem can be regarded as a special form of the Traveling Salesman Problem with Neighborhoods (TSPN)[4,6]

Data gathering [7] problem is to employ one or more mobile robots that can autonomously gather data from all sensors. Mobile robots provided convenient platforms for investigating applications of distributed sensing, in mobile sensor networks.

B. *Characteristics of WSN*

Due to a lack of infrastructure, SNs need to cooperate with each other so as to maintain life and secure information. Each SN has limited power, memory storage, data processing capacity and radio transmission range. Generally, a WSN has the following characteristics:

1) *Ad hoc Deployment:*
SNs are spread randomly and hence they do not fit into any regular topology. Once distributed, the setup and maintenance of the network should be entirely independent and the network should be self-reconfigurable.

2) *Dynamic Network Topology:*
SNs may run out because of limited power or new nodes may be added to the network. Hence, the network connectivity changes with time, resulting in dynamically changing network topology.

3) *Energy Constrained Operation:*
An important bottleneck in the operation of SNs is the available energy. Sensors usually rely on their battery for power, which in many cases cannot be recharged or replaced. Hence, the available energy at the nodes should be considered as a major constraint while designing protocols as well as computational complexity and storage.

4) *Infrastructure-less:*
WSNs are primarily infrastructure-less. There is no central authority to monitor SNs. Therefore, all routing and maintenance algorithms need to be distributed. Sometimes this property becomes main drawback in operation of SN. Due to these property SNs needs to be self-organizing and self-maintaining.

5) *Shared Bandwidth:*
The radio channel in a WSN is broadcast in nature and is shared by all the nodes within its direct transmission range. So, a malicious node could easily obtain access to the data being transmitted in the network.

6) *Large Scale of Deployment*
A WSN is a large-scale network, in which thousands of sensors are arbitrarily spread to track surrounding environment.

C. *CHALLENGES FOR WSN*

The main design goal of wireless sensor networks is to transmit data by increasing the lifetime of the network and by employing energy efficient routing protocols. The design of the wireless sensor network is affected by many challenging factors which must be overcome before an efficient network can be achieved in WSNs. In the following section we try to describe the architectural issues and challenges for WSNs.

1) *Energy efficiency:* The sensor nodes in WSNs have limited energy and they use their energy for computation, communication and sensing, so energy consumption is an important issue in WSNs[3]. According to some routing protocols nodes take part in data fusion and expend more energy. Since the transmission power is proportional to distance squared, multi-hop routing consumes less energy than direct communication, but it has some route management overhead. In this regard, direct communication is efficient. Since most of the times sensor nodes are distributed randomly, multi-hop routing is preferable.

2) *Dynamicity:* Since the nodes in WSNs may be static or dynamic, dynamicity of the network is a challenging issue. Most of the routing protocols assume that the sensor nodes and the base stations are fixed i.e., they are static, but in the case of dynamic BS or nodes routes from one node to another must be reported periodically within the network so that all nodes can transmit data via the reported route. Again depending on the application, the sensed event can be dynamic or static. For example, in target detection/tracking applications, the event is dynamic, whereas forest monitoring for early fire prevention is an example of a static

event. Monitoring static events works in reactive mode. On the other hand, dynamic events work in proactive mode.

3) *Node Distribution:* Node distribution[9] in WSNs[3] is either deterministic or self-organizing and application dependant. The uniformity of the node distribution directly affects the performance of the routing protocol used for this network. In the case of deterministic node distribution, the sensor nodes are mutually placed and gathered data is transmitted through pre-determined paths. In the other case, the sensor nodes are spread over the area of interest randomly thus creating an infrastructure in an ad hoc manner. Each sensor node consists of four major components: sensing unit, processing unit, power unit and transceiver.

4) *Scalability:* A WSN consists of hundreds to thousands of sensor nodes. Routing protocols must be workable with this huge number of nodes i.e., these protocols can be able to handle all of the functionalities of the sensor nodes so that the lifetime of the network can be stable.

5) Data Fusion: Data fusion is a process of combining of data from different sources according to some function. This is achieved by signal processing methods. This technique is used by some routing protocols for energy efficiency and data transfer optimization.

D. APPLICATIONS OF WSNS

WSNs have many applications which are classified into following categories:

1) *Military applications:* For military [1] use, sensor networks are mainly used in area monitoring. For example, soldiers use the sensor network to detect tanks or enemies in the battle field. Sensor networks can also be used for monitoring the status of friendly troops and the availability of equipment and the ammunition in a battle field[3].

2) *Healthcare applications:* Sensor networks can provide interfaces for disabled, integrated patient monitoring. It can monitor and detect elderly people's behaviour, e.g., when a patient has fallen. These small sensor nodes allow patients a greater freedom of movement and allow doctors to identify pre-defined symptoms earlier. The small installed sensor can also enable tracking and monitoring of doctors and patients inside a hospital.

3) *Traffic monitoring:* A traffic sensor network collects data on travel speed, lane occupancy, and vehicles counts by installing sensor nodes along highways. This collected data makes it possible to calculate the average speeds or travel times and enable service such as telemetries. Traffic information can inform drivers not only how to get point from another but also how long it will take to get there, or even direct them to another route in case of traffic jam.

4) *Other commercial applications:* The advance of wireless sensor networks leads to many agricultural, industrial and commercial applications. Some examples are Water quality monitoring[2] involves analyzing water properties in dams, rivers, lakes & oceans, as well as underground water reserves. The use of many wireless distributed sensors enables the creation of a more accurate map of the water status, and allows the permanent deployment of monitoring stations in locations of difficult access, without the need of manual data retrieval.

II. Related Study

Sensor network performance is degraded by the complex monitoring terrain, multihop, and interference and time-varying property of the wireless channel. To make effective use of the gigantic amount of individual sensor readings, it is essential to equip WSNs with scalable and energy-efficient data-gathering mechanisms. Some distinct characteristics of WSNs, such as large node density, unattended operation mode, high dynamicity and severe resource constraints, pose a number of design challenges on sensor data-gathering schemes. Many research activities have been carried out on the research issue. Since the fundamental task of WSN is to gather data efficiently with less resource consumption, to address the problem, there are two threads of research to improve the performance of data collecting: optimized data-gathering schemes and mobile collector assisted data-gathering in WSNs. Most of the Anomaly Detection System proposed in WSN in the literature detect anomalies based on periodic based application using sensor measurement, RSSI, and network traffic pattern. Different authors have proposed other detection algorithms and can be generally classified into five approaches as shown: statistical-based, classification based , nearest neighbour-based, cluster-based, and spectral decomposition-based. Concept of Mobile Robot [1]: The platform of a mobile robot is similar to that of a tank. Hence, they can move on many different planes and have a small rotation radius, these features being good for outdoor WSN applications [2]. The platform for the mobile robot supplied mobility, as well as power, to drive the mobile robot[1], being one single unit supporting the tracks, battery pack, gear box, and two motors.Irregularities[5] in WSN: The complex and dynamic characteristics of WSNs have made them vulnerable to irregularities. Based on the definition, irregularities[5] are observations that do not correspond to a well defined notion of normal behaviours. In WSNs, irregularities can occur in the nodes, networks, transmission channels and application data and can be caused by systematic errors, random errors and malicious attacks. For instance, WSNs may be deployed in a hostile and inaccessible location, maintenance on the network components are impossible. These nodes usually operate unattended over a long period of time until the battery depleted. Node failure can cause the networks to be unavailable. The networks are also susceptible to systematic hardware failure, random hardware and communication errors, and malicious attacks. Irregularities can beNode irregularity, Signal irregularity,Data irregularity, Network irregularity etc.

Pattern Mining: Pattern mining is a branch of data mining. Data mining [8] is the process of discovering previously unknown and potentially interesting patterns in large data sets. The modal of the semantic structure of the dataset is obtained and represented from the ‘mined’ information; tasks such as prediction or classification utilize this model. Finding patterns and elucidating those patterns clearly are the two primary activities of data mining.

III. Proposed Work

My proposed work is given a set of sparsely distributed sensors in the plane, a mobile robot is required to visit all sensors to download the data and return back. The effective range of each sensor is specified and the robot must at least reach the boundary to start communication. The primary goal of optimization is to minimize the travelling distance by the robot. The problem can be regarded as a special case of the Travelling Salesman Problem with Neighborhoods (TSPN) [4], Tiny sensor nodes, equipped with sensing, communication capabilities and computation can be deployed in large numbers in geographical areas to monitor, detect and report events. Wireless networks consisting of such sensors create exciting opportunities for large-scale and surveillance applications. In many of the applications, it is essential to mine the sensor readings for patterns in real time in order to make intelligent decisions.

Detection of sensor data irregularities is useful for practical applications because the patterns found can be used for both decision making in applications and system performance tuning. For example, irregularities in sensory data are of interest of monitoring applications. For this kind of applications, the communication cost can be reduced if only normal sensory values, as opposed to all values, are transmitted.

The problem of irregularities detection is to find those sensory values that deviate significantly from the norm. This problem is important in the sensor network setting because it can be used to identify abnormal or interesting events or faulty sensors. The evaluation will be done according to the following metrics:

1. Packets Transmitted with and without anomalies
2. Energy consumption with and without anomalies

IV. Methodology

A. Proposed Methodology:

A new approach named pattern variation discovery is used to solve this problem. Our approach works in the following steps:

1) Selection of a reference frame:

This frame consists of the directions along which we want to look for irregularities among multiple sensory attributes. An analyst can explicitly specify the reference frame. It is also possible to discover the reference frame that results in a lot of irregularities.

2) Definition of normal patterns:

This definition can be models of multiple sensory attributes or constraints among multiple attributes.

3) Discovery of irregularity:

Whenever a normal pattern is broken at some point along the reference frame, irregularity appears. That is, the pattern variation happens.

B. Detection of sensor data irregularities:

For example, we want to discover the irregular distribution pattern among multiplesensory attributes along time. Then, for each

time point, we can put the values of a groupof sensory attributes at a series of sensornodes into a matrix, which represents adistribution status. The problem then becomes

to discover the irregular matrix among a set ofmatrices. An irregular matrix represents that,at the corresponding time point, thedistribution of pattern of all the sensoryattributes on all the nodes are irregular.Detection of irregularities is tightlyinterrelated to modeling of sensor data.Therefore, we propose to detect irregularsingle-attribute sensor data with respect totime or space by building models.

V. Simulation Setup And Scenario

In the studied scenario we take network of 30 Nodes & Detect or Filter out the Anomalies Or Irregularities when we look at the animation of the simulation, using NAM. The output can be analyzed by observing the

Screenshots of the NS2 network simulator:

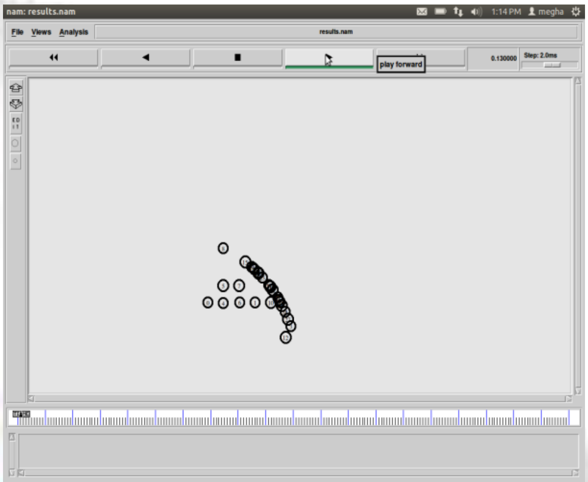

Fig. 1: Mobile nodes at initial states

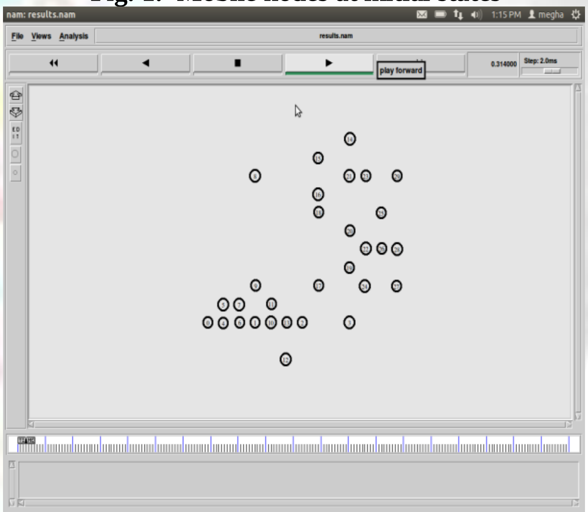

Fig. 2: Mobile nodes when network is created

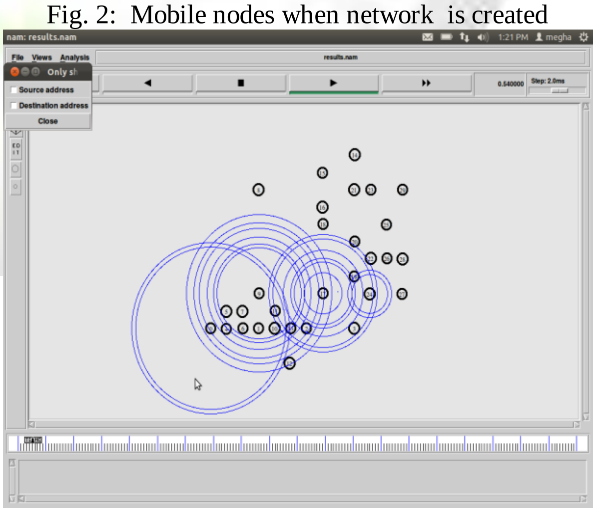

Fig. 3: Transfer of Data from node 24 to node 0 via node 17 to 9 to7 to 5.

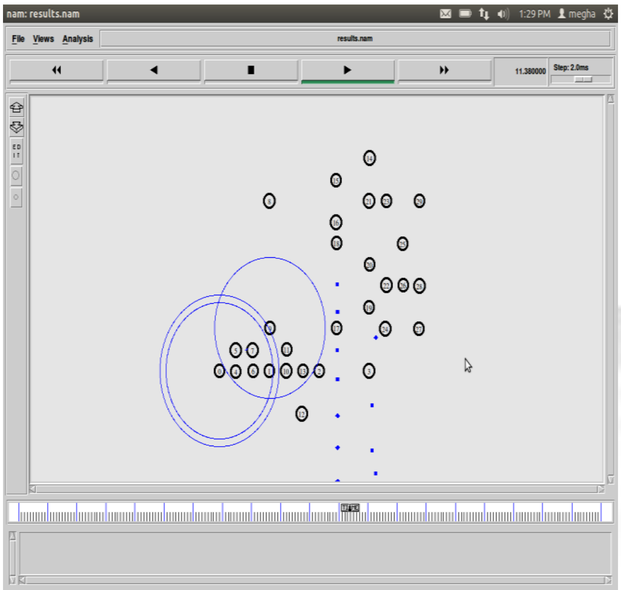

Fig. 4: Irregularities or Anomalies Detected and Dropped out in form of Packet Droppings.

VI. Simulation Results

A. Scenario One

1) Packets with & without Anomalies

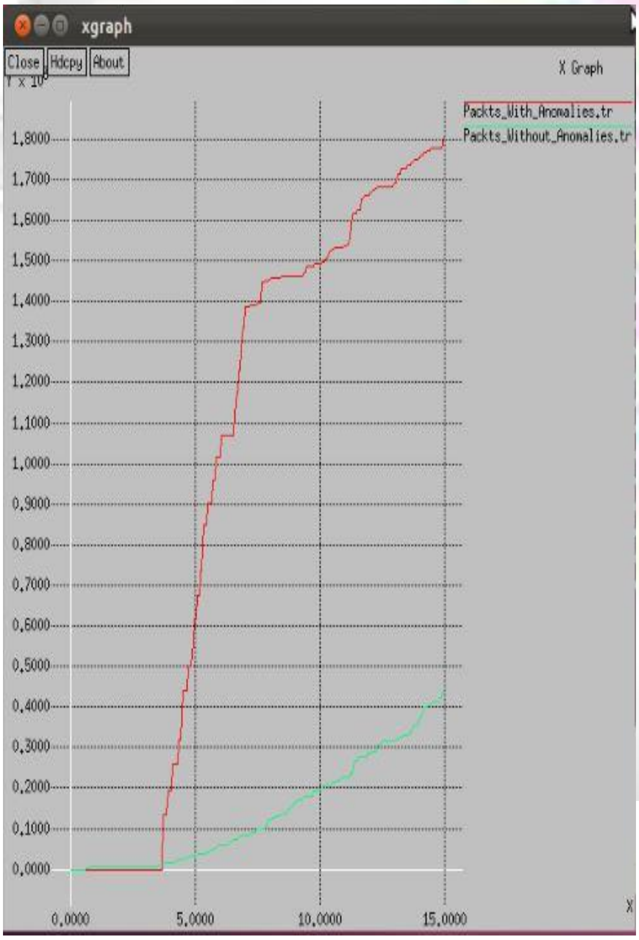

Fig.5: X-graph of packets Transmitted with and without anomalies

B. Energy Consumption with & without Anomalies

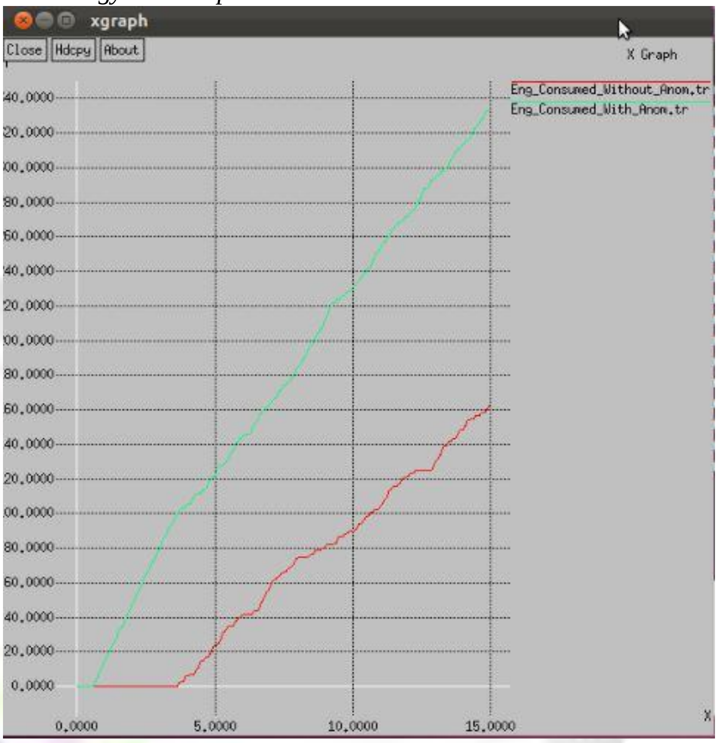

Fig. 6: X-graph of Energy ConsumptionWith and without anomalies

C. Scenario Two

1) Packets with & without Anomalies

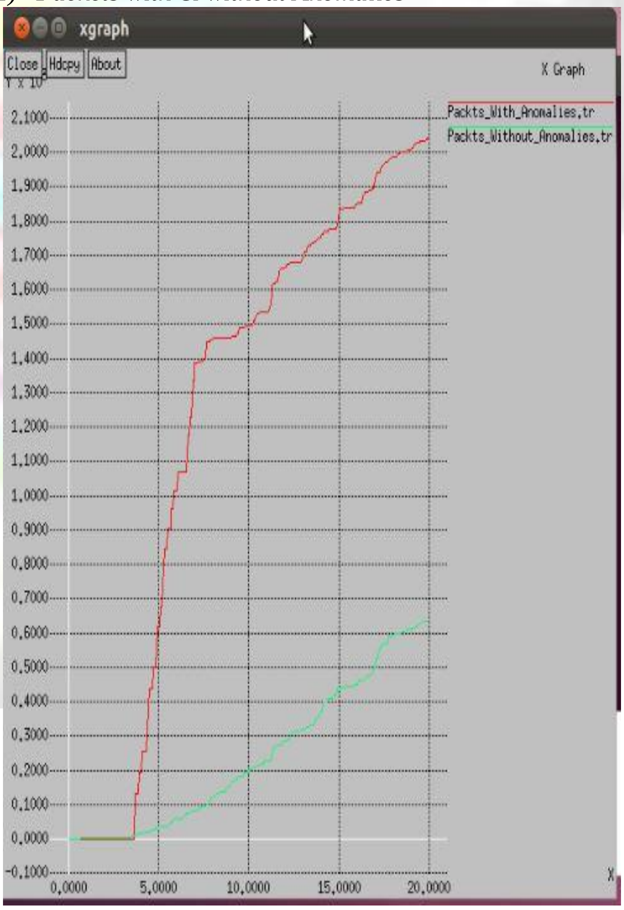

Fig. 7: X-graph of packets Transmitted with and without anomalies

D. *Energy Consumption with & without Anomalies*

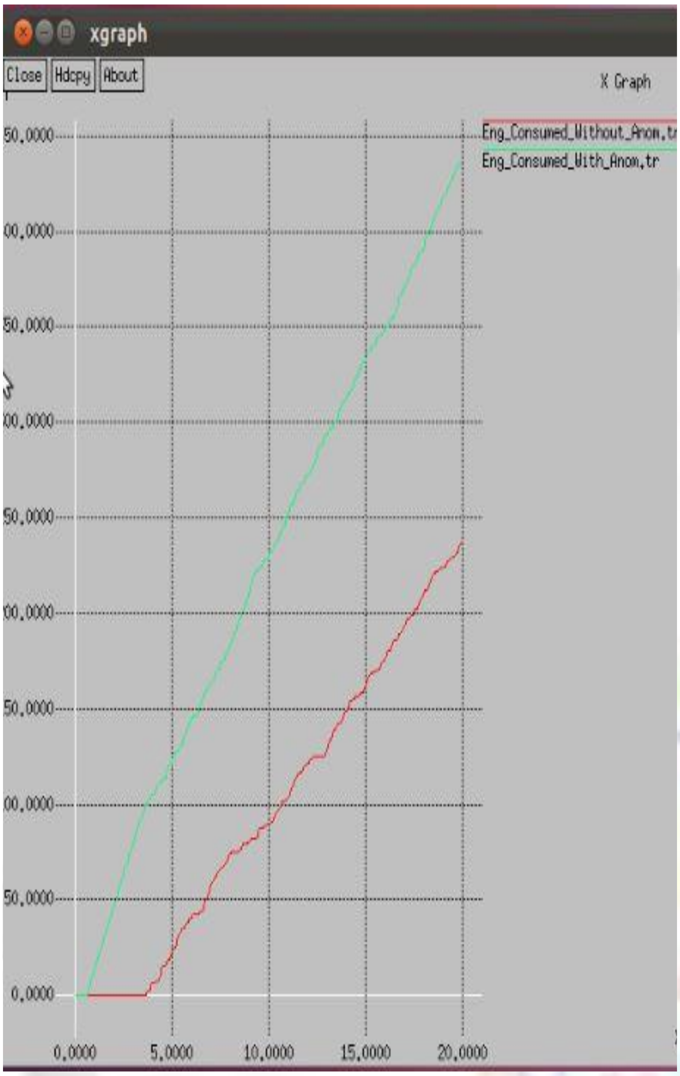

Fig. 8: X-graph of Energy Consumption
With and without anomalies

VII. CONCLUSION

Enhancement of AODV protocol by using concept of mobile robot on the basis of Anomaly detection & Energy Saving.

We conclude that with different Scenarios our results remain consistent as mobile nodes have capability of dynamically changing topology.

Packets get Filtered, Filtered Packets consume less energy when they are transmitted as a result overall energy of WSN is saved**.**

This approach has the clear advantage of Energy saving in WSN, and Detecting the packets with anomalies.

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