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Research paper



Efficient and Compressive Hybrid Data Dissemination Model with Data Aggregation in Healthcare Applications Using WSN

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Abstract

Wireless sensor Networks (WSN) have great attention within the past years to provide the choices of flexibilities and save the value of patients and health care activities. Constant time, during disaster events, there is a developing health care area which is able to produce actual care to the patient. For the reason, equipment's are modified to observe the patient that has great attention to enhance the efficiency and Quality value of health care. Huge amount of real-time information on the hospitals Sensors used to monitor the patient information that turns out a progressively. The medical data of a private is extremely sensitive; it is an important problem in a hospital during the transmission of this information through wireless networks. For communication the information size get reduces in data aggregation. This paper aims to reduce the traffic within the cluster so as to enhance the energy efficiency and for that purpose a hybrid data dissemination model is proposed which uses the enhanced comb needle model and compressive data sensing. Comb Needle Model is the simplest network that can be compared with proposed hybrid data dissemination model by exploitation the parameters like the ratio of packet delivery, average delay, throughput, and cost of communication and intake of energy.

Keywords*: Wireless Sensor network, Healthcare application, Data aggregation, Energy consumption, Compressive data sensing*

1. Introduction

The wireless sensor networks consist of huge amount of popular nodes has wireless connection which is near future are envisioned, each node with some power usage for computational and capability of monitoring, operating the unused nodes in the networks. They projected a huge variety of applications which monitor the environment such as vehicle tracking to habitat monitoring [1]. In these networks, the hardware technologies such as processors is minimizing the cost, sensing is minute and radio modules – are still available, with their enhancement of the network, which offers cost and the expected capabilities within the next decade [2]. Essentially, the Sensor networks are event-based systems, whereas a sensor network has more than one "sinks" by expressing their queries which contribute the particular data streams.

The sensor nodes in the WSN which is elected the "sources" that can monitor or detect the events in the environment and transmit the data which is relevant to the accurate subscriber sink node. There is no infrastructure for WSN that can lead to failing because the sensor nodes are unreliable with wireless links. Energy saving requirements are difficult in WSN routing protocols. For better routing, to avoid congestion and reduce the transmission of information through a path which is short. A Factor that is used to reduce the information size and improve the network lifetime such as flooding, localization, neighbor detection is efficient, time synchronization, and dissemination of query. The restriction of sensor node is to design a protocol which is used for routing in WSN that has limited power usage, which is mandatory for design the protocol that is energy-efficient communication. Communication between the nodes and Base Station the term Clustering is used, while energy become efficient with the comparability of single or multi-hop routing.

In clustering, a group of nodes which elected Cluster Head (CH) and the packet can be transmitted from one node to an isolated node [3]. Whenever energy depletions is occurring in clusters that time some of the Cluster Head nodes are overloaded, in order to overcome this problem we introduced load balancing (equal nodes to a cluster).

In this network, the nodes are formed into clusters. The Cluster Head (CH) node that presented in the cluster control and organizes the nodes and communicates with the nearby group heads in the network. The cluster- based model utilizes two categories of nodes such as the root node and aggregate node. In router node, data packets are routed towards the sink node, whereas for aggregate the data packet nodes are transmitted to intermediate node using the aggregation function. The node which is intermediate between the source node and the destination that can gather the information and transmit it. With the help of multiple sink nodes the network lifetime is an enhanced technique called data aggregation, which depending on linear programming [20]. By increasing the wireless sensor network performance, Heuristic-based data aggregation protocols are used to change the network traffic conditions.

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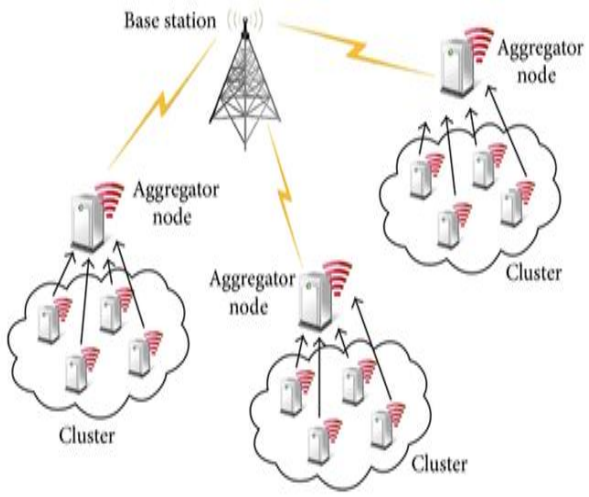

Figure 1:. Data aggregation in WSN

Recently, wireless sensor networks (WSNs) have been focusing on research area the issues are ranging from the research applications which are theoretical to practical. Technology always provides the way for improving the quality of surviving in the society. Based on the medical applications range, the number of medical centers and hospitals are exploring the applications in WSN technology, which include pre-hospital and stroke patient rehabilitations, disaster response, and in-hospital emergency care. To track or monitor the patient and all medical resources we embedded WSNs into a hospital building.

We design, wireless sensor networks for medical applications usually called as wireless medical sensor networks (WMSNs). In the 21st century, the Wireless medical sensor networks to provide some important enhancement of the healthcare industry [22]. The medical sensors are attached to the patient's body and it can monitor the patient's physiological condition. The medical sensors can monitor the sick person's body conditions (e.g., blood pressure, temperature, oxygen saturation, heartbeat rate, etc.) and without any human intervention the data are transmitted to some remote location depend on time. The doctors analyze the readings to provide treatment for the patients. The people have benefited while monitoring continuously after discharging from the hospital. In the future, WMSNs will play an important role in modern healthcare and important one is ubiquitous monitoring becomes increasing in order to facilitate the cost reduction which require the interaction of physicians and their patients.

The Emerging technology of Wireless sensor networks has a variety of applications like health care. The technology of WSN is revised based on the practical application design of Health Care WSNs (HCWSNs) which support requirements of key system architecture of energy efficiency, communication is reliable, support mobility of node, multicast technology and appropriate data delivery [23].

In WSN, the Data compression aims to condense the power consumption of the system. The origin of Compressive Sensing (CS) is the field of signal processing.

Compressive sensing Advantage is, whenever the signal gets sparse in a known basis, expensive measurements (computation at the sensor end), and at the receiver end, computations are cheap [5]. The characteristic is matched completely in WSNs. When the comparison of data compression, compressive sensing is applied in WSN which offers the enhancement, which is promising in minimum power of nodes that cannot be suitable for encoding partial implementation in data compression techniques. Here in this research, it concentrates on resolving the existing issues of the compressing sensing techniques and proposes energy efficient and effective compressive data aggregation in the enhanced Comb-needle model based on the cluster.

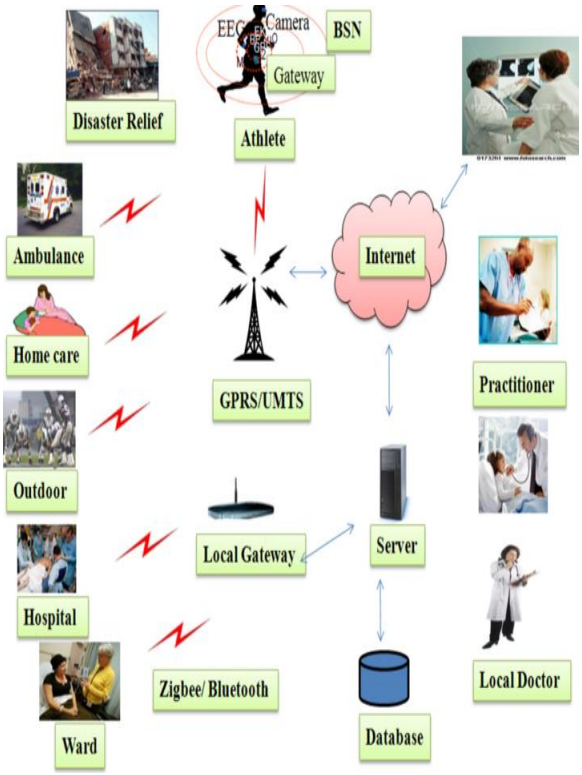

Figure 2:. Healthcare applications in WSN

Aggregation of data utilizes the parameters of sensor nodes for combining the cluster the attributes are chosen and stored in an aggregated structure of future utilization. Aggregation mechanisms that the information is formed by pattern and data is formed like dimensions that can be simple to store and retrieve.

The mechanism of data gathering is being applied to a data structure which is used to store and gathering the information. In the recent past years some major issues are found were energy consumption is high in the battery [18], still proposed several schemes for data aggregation which is effective till now various drawbacks are there [19]. To solve these drawbacks, the proposed technique is effective and efficient while performing the best.

On recent scenario, compressive sensing is based on data aggregation techniques that received the attention to researchers as these methods can improve the network life by decreasing the amount of data transmitted and equilibrating the traffic load throughput the wireless sensor networks. The efficient compressive data aggregation (CDA) technique is used to improve the both the network's lifespan and the cost of data transmission of large-scale wireless sensor networks. The author [21] has evaluated the network's capability by utilizing the compressive data aggregation technique and demonstrated that the capacity was directly proportional to the sensed data and disseminate them throughout the network utilizing a simple algorithm.

2. Literature Survey

In data aggregation, the rule of key communication plays a dynamic role in the wireless networks field. In this literature, we discussed about various aspects of performance is associated with data aggregation.

In compressive data gathering concentrates on the data gathering snapshots. In compressive data aggregation, measurement matrix is haphazardly generated and the signal was specified by utilizing wavelet transform or discrete cosine transform. Compressive data aggregation was not desirable in the small scale wireless sensor networks where the possible capacity gain was very meager and the signal sparsity would not be high enough for obtaining the signal strength
.
Ji et al [11] had analyzed about the snapshots and uninterrupted data aggregation issues in the physical inference model. For increasing network capacity, snapshot data aggregation employs the network segmentation to agenda the compressive sensing procedure of each sub-network and therefore the optimal capacity of the network can be received; uninterrupted data aggregation applied a pipeline scheduling algorithm to accelerate the compressive sensing procedure in the network. Signal strength is low this is the major disadvantage in this paper.

Luo et al. 2009 [6] proposed a novel CS data aggregation scheme is used for the data that needs to be transmitted is reduced by integrating CS as a compressing technique and thereby to improve communication power efficiency Transmission of an equal amount of data for each sensor regardless of its position and its role in the aggregation routing path introduces redundancy and entails unnecessary energy consumption.

In order to solve this problem, an HCS aggregation scheme was proposed where sensors apply CS only when the number of data items collected exceeds threshold, otherwise sensors combine the received data with their own data and send them directly, which is the same as the conventional data aggregation scheme.
According to Lee et al [12] had investigated the compression ratio and recovery quality and consequently developed to cluster based on the compressive sensing approach. The existing work majority is used only for spatial correlation and they consider determined compressive sensing pattern that means the compressive ratio was also determined but the complexity of the network is high.
Lmdsey [7] proposed a data aggregation algorithm, whereas the cluster is separated by rounds and each round contains phase one is set up and the second phase is steady state, before going to first round the network become partitioned. First, the whole network is partitioned into small rectangular regions is known as swim lanes, and then a grid is the smaller rectangular regions subdivided by every swim lane. By evaluating each grid in the network the Cluster Head is chosen base for more energy saving capacity. In a grid, the cluster head node occupies more energy that may lead to the cluster head these processes can be done routinely and also share their load.

Intanagonwiwat et al. [8] discussed about the greedy aggregation scheme [8] that the aggregation approach is tree based. The Novel approach is used to increase the path sharing and reduce the energy usage. The construction of the greedy incremental tree that established a path which is shorter between the source nodes to the sink node while connecting the closest point the other sources is incremented on the existing tree. In the tree, to find the closest point the cost of increment the energy field is updated with closer nodes. In high density networks, the greedy aggregation is achieving the energy saving up to 45% with the favor of latency.

Madden proposed an algorithm for data aggregation tree to construct and maintain the sensor networks [9]. The algorithm initiates sink node that broadcasts the control message. The aggregation tree with a sink node which act as a root node.

Five fields in the control message such as residual power, Sensor ID, status (either leaf or non-leaf), parent and finally count the number of hops from the sink. Initially, receiving the control message from the node, the timer is set for sensor node. The node which receives the control message that is marked as parent node, others nodes are marked as a non-leaf node itself. The process which is carried out on until broadcasts once each node and then result of aggregation is send back to the node sink.

Shin [10] was proposed a PEGASIS which is Chain based Data Aggregation approach. For data aggregation, the nodes are arranged in PEGASIS is like a chain. The chain like structure is formed by the nodes that make use of a centralized manner or in greedy algorithm, the sink node can decide the chain. Each round of data gathering, the node will receive the data from its neighbor, the data can be fused to its own and the data which is fused that can be transmitted to another neighbor node along with the chain. Finally the header node gets transmits the aggregated data to the sink node.
Authors [13] had proposed a distributed compressive sensing method for the correlated signals. It created a greedy algorithm depend on the joint signal recovery scheme, which rebuild various signals developed by sensor node in a wireless sensor node where these signals were accepted to meet pre-defined joint sparsity prototype. By existing methods, compressive sensing has determined their basic retrieval algorithm to greedy algorithm and linear programming [11]. These methods had suffered from accuracy, complexity, and speed issues. Bayesian compressive sensing (BCS) was a method, which used statistical characterization of the signal to complement the conventional approach.

Other than precision or quality of data, delay, the energy efficient algorithm was also provided better performance of data aggregation. Pharm et al was first detecting the trade-off between energy efficiency and data aggregation quality [14].

Zhu et al [15] analyze about the quality of service to estimating the exact precision needed for completely specific task in the data aggregation of WSN. Tang and Xu [16] had illustrate about the data processing which gathered from different nodes to improve the network lifetime and reduce the consumption of energy. They proposed different papers, which aim to enhance the quality of data in the given time or aggregation of data consuming energy [17]. Particularly, concentrated on the lifetime of the network to reduce the error bound necessity, when they tried to meet arbitrary precision requirement of several data aggregation applications is a significant manner. Overall Network delay is high.

In rural areas 9% of physicians are working, but, in rural areas nearly 20% people population [25] and also lack of physicians and specialist. In this technology have the potential to enhance the issues of the patient problematically. Benefits At-home care can provide financing to improve the quality of the patient's life, and more effectively decrease the prevention of detection or monitoring long-term chronic diseases [26].

Gaddam Anuroop and et al a novel system is designed for home monitoring which contain cognitive sensor network and is proposed for elder-care application. The smart system contain optimal amount of cognitive wireless sensors which is used for detecting the electrical device usage, bed pattern usage, flow of water and as well as fit in panic button. The sensors which cognition that can provide the information which is used to monitor and detect daily activities about any abnormality pattern around the house. The system can generate the message and sent to notice message early to the provider, while unexpected anomalous situation happened. Still every system using small amounts sensor only, because the sensor captures the person's daily irregularity with necessary usage of appliances. In residential environments the system is installed and maintained with ease [28].

3. Research Methodology

The main aim of the proposed model can be done in cluster based comb needle model to enhance energy efficiency and to improve the data aggregation in healthcare application.
Here, enhanced cluster based comb- needle to propose the hybrid data dissemination model to handle the inter block energy and neglect the spreading of intra-block hotspots, can be significantly grouped to specific block to form a global block transmission for effective energy consumption during transmission. It includes the compressive sensing method in enhancing the comb- needle model to obtain the higher compressive ratio, consumption of energy and data transmission. Here we are discussing three models. They are

i. Enhance comb needle model based on cluster
ii. Compressive sensing method
iii. Hybrid data dissemination model

A. Enhance comb needle model based on the cluster

In this model, whatever data the node gathered that data is transmitted to its certain neighborhood nodes and in the network, the query is distributed in particular group only. Moreover, dynamically the query is processed to build a routing structure, then comb resembles and the data duplication structure is pushed by the sensor nodes just like a needle. One can view like this process of querying is just like combing for needles in the sands or haystacks.

The approach which is based on Cluster the groups of nodes in the WSN having a particular number of clusters. Each group has one Cluster Head (CH). In each and every cluster all sensor nodes gathered their information and sent it to their Cluster Head (CH). Then the data are processed by CH and the data is forwarded towards the sink which is moving. High battery power in sensor nodes which are considered as CHs. The sensor node which is assumed as fixed one and it cannot mobile.

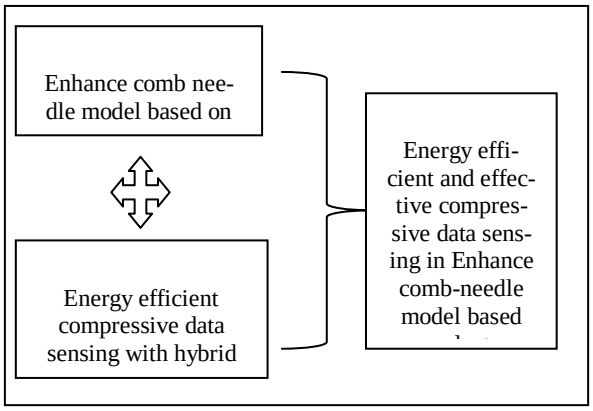

Figure 3:. Proposed System architecture.

a) Analysis of enhanced comb needle model based on the cluster

Evaluate the "Enhanced comb-needle" structure which is formed by grouping the number of nodes. Examiner assumes the patient's body that has number of sensor node, total number of cluster and size of the cluster which is fixed.
We assume m x m grid is regular, and M is the nodes present in the patient's body.

$$M=m \times m \quad (1)$$

To estimate the query communication cost as follows: Generation of each event forms a length of the needle 'ln' from the comb and each needle communication cost is

$$Cl = ln-1 \quad (2)$$

In case of emergency the event of the node will. The following parameters are defined:

fq=Frequency of the Query
fe=Frequency of the Event
fd= fe/m2 , Each sensor nodes frequent events

The event is generated and then passes the data in two upward direction,

$$ln+m+d1 \quad (3)$$

The event is generated and then passes the data in two downward direction,

$$ln+(m-d)+(d-d1) \quad (4)$$

The Query reply cost for basic model of Comb-Needle is

$$Cqr=2(m+ln) \quad (5)$$

B. Compressive sensing method

The main aim of the compressive sensing data is overall energy is reduced in all aspects such as the cost of energy sample, cost of communication, and complex calculation. Illustrate the signal which is compressed by Compressed Sensing (CS). In our model, Let consisting of M nodes in the patient's body. Assign each node have an ID, m, the range up to 1 to M. Assume, nodes generate the readings that can be positive real numbers and also assume time slots equalized.

With the algorithm named Centralized Exact, every node analyses the environmental condition and forwards their reading to the server PC during each time slot. As a result, for each time slot, M readings are collected by the server PC. For time slots T, collect M × T readings. The readings are organized by M × T matrix X, where the number of rows and columns is correspond to their node ID and number of time slots respectively. As a result, from each node only few readings can be transmitted to the Server PC, leads to different benefits such as traffic reduction and enhance the network lifetime.

C. Hybrid data dissemination model

The proposed hybrid data distribution includes enhanced comb needle model based on cluster and compressive sensing data.

Healthcare application, the data aggregation in clustering can make congestion, which may lead to fatal of patients. Traffic reduction and consumption of energy, by applying distributed data aggregation technique to enhance the comb needle model based on the cluster. During the process of Data aggregation the wireless module gets the message from its leaf nodes in the tree by allotting particular amount of time [29].

Repeater get aggregates its status message with its leaf nodes is received, and then forwards to collection device which the data are aggregated to the wireless module. The hybrid method is a combination of push-based and pull-based techniques [30] which introduce the combination between consumer node and source node. Source nodes get the information about storage location is the first phase and then sensory data is transferred with assignation nodes which are closest to the location. Then consumer nodes having same regulations that can directly transmit the query to assignation node. In this way, efficiently a query flooding is avoided.

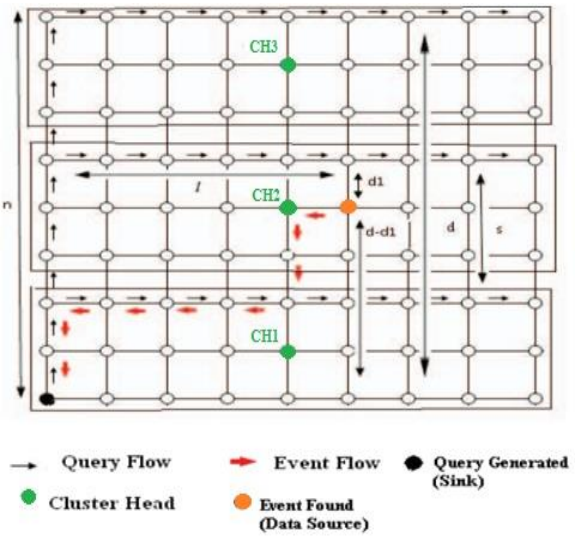

Figure 4:. Cluster based comb needle model

4. Experimental Analysis

The proposed work performance is evaluated by using the following metrics:

a) Packet Delivery Ratio (PDR): The amount of packets received in destination node which is sent from the source node.

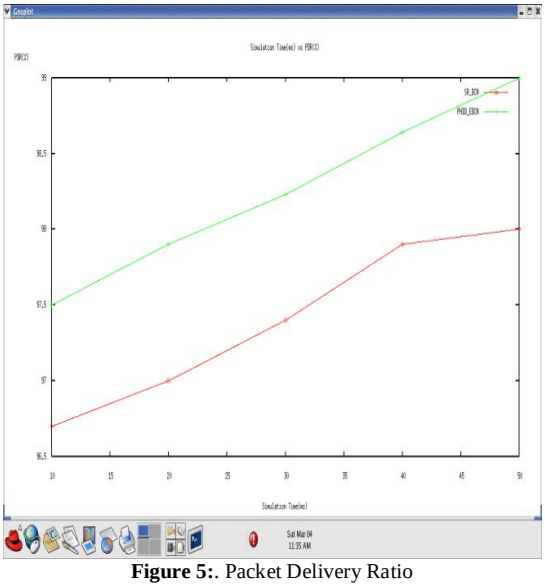

Figure 5:. Packet Delivery Ratio

b) Throughput: In the random networks, the message which is delivered over a communication channel successively.

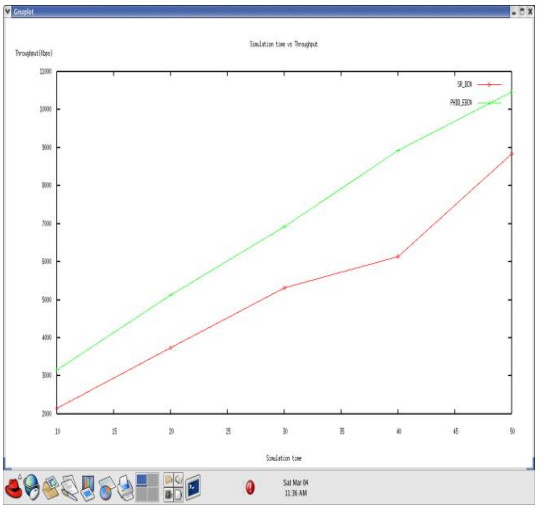

Figure 6:. Throughput

c) Average Delay: time taken for the packets which is transmitted to sender and receiver.

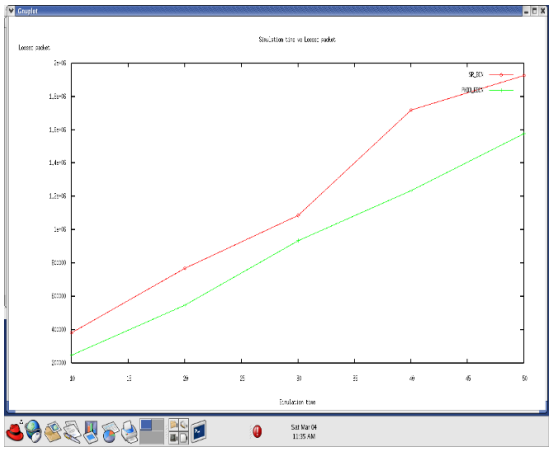

Figure 7:. Packet Delay

d) Consumption of Energy: the average energy supply is calculated on data processing, idle sleep, monitoring, and transmission of data.

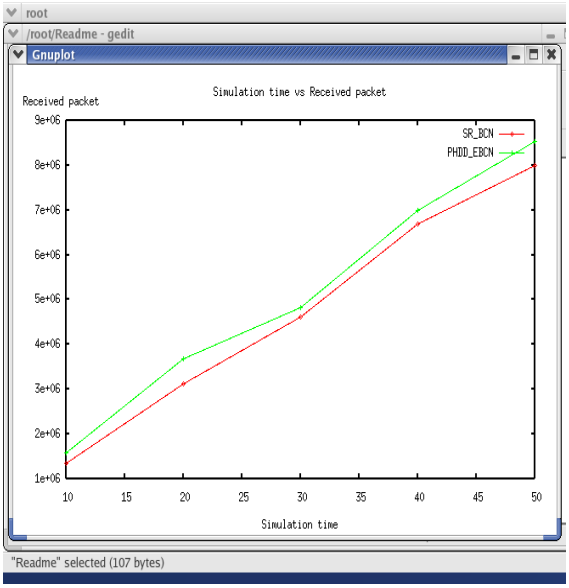

Figure 8:. Energy consumption

e) Cost for Communication: the amount of packets is used to transfer between the source and destination.

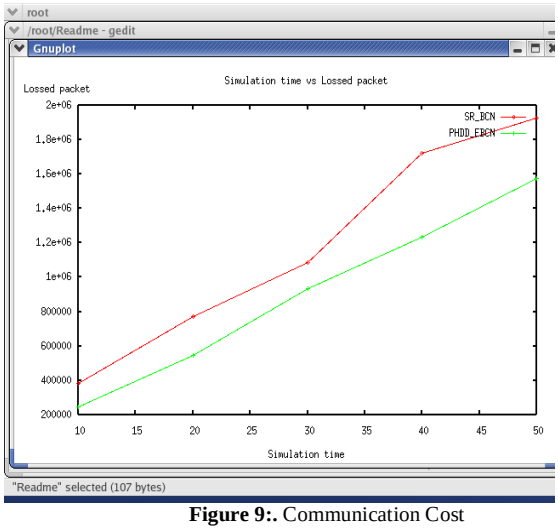

Figure 9:. Communication Cost

Table 1. Compare the basic model of comb needle in Simple network and proposed Hybrid data dissemination model with enhanced comb needle model based on the cluster

Parameters	Basic comb needle model having a Simple network	Proposed model is Hybrid data dissemination model with enhanced comb needle model
Packet delivery ratio(PDR)	92.34	98.23
Throughput	88.34	102.56
Average delay	0.2970	0.1721
Consumption of Energy	84.27	56.86
Cost for Communication	6542	10423

5. Conclusion

Recent research areas in medical wireless sensor networks that can be enable their knowledge for monitoring the remote patient. The paper considers the problem in wireless sensor network the transmission of data in the medical field such as delay, power consumption, and congestion. In order to reduce those problems in the network compressive sensing method with the enhanced comb needle model is proposed here. It compares the performance of proposed Energy efficient & effective compressive data aggregation in enhanced Comb-Needle Model based on the cluster with the basic Comb-Needle Model with the following factors, such as consumption of energy, compressive sensing and cost for communication.

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