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Modeling of Wireless Sensor Networks in an Energy-Efficient Manner Using Quantum Physics

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Abstract

A Wireless Sensor Networks (WSNs) consists of huge number of Sensor Nodes (SNs) which communicates to each other by wireless technologies. Modelling of WSN becomes unmanageable when uncertain conditions of the network occur. A significant issue ofWSN in the present scenario is the inadequate availability of energy within SNs. Therefore making optimal use of energy is essential in modelling a WSN. In this paper, we have proposed a novel model of WSN by using the concepts of atomic bonding on a 3D plane using a percolation model, which is a random graph in those edges are formed between the neighbouring SNs. We have related the Energy model of an atom, concepts of Electromagnetics, Quantum Mechanics and Wave Duality to WSN by doing an approximate exploration of the severalprinciples and theories. The positioning of SNs are determined by the model, which is developed by the investigation and analysis done wrt atomic bonding theories. Our model developed by using the concepts of graph theory and probability distribution will be more efficient in terms of energy consumption and power utilisation.

Keywords: *Wireless Sensor Networks, Energy efficiency, Electromagnetics, Quantum Mechanics,Wave Duality etc*

INTRODUCTION

WSNare deployed to collect data from the environment depending upon the range of the SN and send it to the Base-station (BS) [1,2]. In WSN, usually huge numbers of SNs are deployed since the area under consideration is also very large to monitor. It is a complicated task to organise the SNs in an appropriate and suitable manner by manpower, so it will not be able to monitor the entire coordinate region under its surroundings. Most of the WSN are deployed by the random distribution of the SNs. So the SNs are not aware of the locations of their neighbouring SNs until the network is not established which leads to uncertainty and ambiguity in the WSN.Energy of the SN is a scare resource in WSN. Thus the most significant goal in investigating WSN is to propose novel conduct and ways by which energy should be efficiently managed, power utilisation, topology control approaches, new routing algorithms, special MAC protocols, data aggregation, area of monitoring and review on implementation of WSN [3, 4]. Dense network analysis of protein is given in [5], concepts of quantum physics linked to be linked with wireless networking are given in [6].

The fundamental point in the paper is to relate the ideas of nuclear structure with the ideas of remote organizing as both are taking a shot at a similar guideline of wavelet. To make this model idea of likelihood, Probability dissemination function (PDF), Cumulative distribution function (CDF)and so on are together broke down. The significance of permeation hypothesis for phase change is additionally vital for expanding the vitality

effectiveness in any remote system [7] has portrayed as to significance of phase transition wonders through which better structure of WSN's could be developed. It isdepicted that with respect to the similar-based model, Omni-directional communicate of the signals for bonding, and furthermore with respect to utilization of directional receiving wires which could be utilized for the simple transmission [8]. For this situation a great deal of copy pockets of signals are secure. Realistic dynamics are given in [9].

Here the idea of Electron model of the particle is included. The ideas of Bohr's nuclear model are used to make the system the board in the framework. The vitality appropriation of Maxwell conditions are additionally used to make a model, which is energy proficient. It has been depicted [10] with respect to an calculation in which a few nodes are chosen to be like a cluster which depends on the environmental position of the sensors. This paper significantly manages the inexact investigation of Atomic Bonding Models considering and somewhat endeavoured to relate these speculations with the demonstrating of remote systems. The probability conditions included are taken from the research [11]. Additionally different strategies are included which takes the instances of same cases.

The case considered in this research is a very specific section, which is having sensor nodes as a work G (S, E) where S indicates the sensors in that specific region being under region, and E indicates all the current correspondence associations. A method is engaged with which the measure of nodes over a zone where the signal is to be transmitted will be given with the power and the rest of the nodes will be in the off stages. This will spare a ton of intensity as a way will be chosen and the signal is made to course through that way as it were. Because of this, there will be less instance of cross polarization between the signal travelling. Some source of energy can also be provided in the middle of travelling to the signal. The rest of the paper is showed in the following ways: Section B gives the brief presentation with respect to the related work. In the segment III, the connection between the remote systems administration and quantum material science is created, estimate in the likelihood regarding vitality, speed, position is characterized. Improvement over the spoke about model with respect to the power the executives is likewise given in a similar segment. More discussion about the work are clarified in segment IV. At long last end is in area V.

RELATED WORK

Geographical Adaptive Fidelity Algorithm (GAF):

In GAF algorithmfew SNs of the WSN are selectedon the basis of their geographical location. The area under monitoring is partitioned into numerous small lattices forming a cluster. The cluster size matters as it should meet the requirementsof the communication in which the signal must flowbetween two farthest feasibleSNs. Let us assume a virtual lattice square with r units on a side and denote the radio range of the sensor by R.Thus we get,

$$r^2 + 4r^2 \leq R^2$$

In this the SN of the cluster are active and inactive episodically. The active SN can exchange data from its side SN and a new cluster election occurs. The Cluster head (CH) will remain active throughout its lifetime but the cluster member nodes (MNs) can sleep when there will be no sensing task. Cluster head is kept active all the times but the cluster members sleep in case there is no sensing task.

Site Percolation

In this WSN will be a random graph, the edges of which are formed between two neighbouring SNs. In site percolation either SN is considered as an open port with a probability (likelihood) p or a closed port with a probability of (1- p). An

edge can exist only when there is a connection between two open ports of SNs. Site Percolations can be understood as a sudden change from the finite number of clusters to infinite number of clusters where p increases to P_c.

Random Graph

A random graph consists of edges and vertices. An edge can connect any two vertices with the probability p. Any two vertices share an edge with the probability of p. It has been described by the authors of [12] that the probability (likelihood) of a random graph being connected tends to be one if the number of the edges taking part in the connection is greater than P_c= (N/2*log N). Due to this there is huge change in the performance of the system; this is phase transition in the random graph theory. The value of$P_c$will belike a threshold value for the probability distribution as if a certain network has this sought of probability distribution then that random graph is connected.This mapping technique is althoughimpractical and unviableas we have wireless edges for network connection.So logical pairs of vertices are required to be created, SN has limited communication radius.

In the model given by the authors of [13], they have taken the case of a random graph containing origin, thenconsidering the expected value of this network system when it will be large consisting infinite number of links. Let D_o be the connected component containing the origin and denote the links by modulusof D_o. Now taking this network to a large network we take the mathematical Expectation value E (modulusof D_o).

$$E(|Do|) = \sum_{n=0}^{\infty} (n\, P\,(|Do| = n)$$

The expected value is in the form of increasing function of probability p, and will be available as equal to infinite when the value of probability goes to p = 1.

Actually the value of P is a thresholdwhich is used to decide whether there could be a condition of well-connected WSN. One morecondition which could be used for deciding the connection of network is the taking the set of infinite network and studying the expectations of the different cases.

MODEL CONSIDERATION

Thought of Energy, speed and dislodging

The radius of the round circles chose for the arrange display relies upon the affectability of the systems. In this way, largely the sweep is determined by thinking about the PDF of the detecting system. The PDF of the system will give us the rate at which the probability is changing with increment in distance from source node. The case is considered and it has been found to have the radius of the roundabout examples as delivered by the nodes of a reception apparatus of a y-node is practically 0.75 occasions the distinction between the radius of the round circles. The verification is given beneath from the accompanying outline:

In similarway, the range continues diminishing by moving inside the circles however, the contrast between the ranges of the two circles continues as it.The other progressively imperative thing is to choose the remove between the circles or the distinction between the sweeps of the back to back circles. For this issue the arrangement is specifically taken from the Bohr's Nuclear Theory. The difference between the ranges of the sequential circles of systems will be straightforwardly relative to the electrons circle as that for an atom. We really compute the estimation of the distinction in the energy, which will be required as the real viewpoint, which will be required, is the distinction between the energy of the particular circles of the remote arrange. Because of Bohr's Atomic Model we have the energy scattering distinction is given as:

$$\Delta E = \frac{2\pi^2 Z^2 e^4}{n_2^2 h^2} - \left(-\frac{2\pi^2 Z^2 e^4}{n_1^2 h^2}\right) \quad (1)$$

Here Z=Atomic No., N = Number of orbit, E'= Energy deviated by one hydrogen atom to bind the electron in its orbit, M = mass of electron, n = orbit number, e = charge on electron.

The condition demonstrates that the adjustment in energy is specifically subject on the estimation of nuclear number also, the estimation of the circle in which the molecule is present. In the analogous way the model structured will have indistinguishable qualities from the energy gave to the switch so as to send the signal from one node to the next will be subject to the estimation of the separation of that specific node from its goal, the estimation of the separation is ended as a specific estimation of circle (this is generally done by somewhat determining the quantity of nodes between the way). It willequallycount on upon the kind of the signal which the client needs to send. Typically, the recurrence which is sent through the remote systems is high however, may contrast because of which the estimation of energy change. Consider the case that if a signal comprising of high recurrence is sent in light of intensity taking the recurrence to be moderate then the signal has the opportunity to be lost either in the mid of nodes, blended with disorder and so on. In this way, change in the recurrence of the signal assumes an imperative job in the exchanging of signs.

Along these lines, from the above parameters we can say that the energy given to the switches ought to be straightforwardly corresponding to the estimation of its recurrence and it ought to likewise be straightforwardly relative to the separation between the goal SN and the source SN (in a roundabout way corresponding to the quantity of the nodes that comes in the mid of the exchanging of signal)
Therefore, E

$E \alpha f$

Where E= Energy given to the switch,
f= recurrence of the signal.

Along these lines, on the off chance that we think about this equation with the instance of remote detecting then the vitality deviation in the bigger circles will be higher than the lower circles. By this we can say that the vitality given to the nodes at higher circle span must be higher than of inward circles. Since the vitality of the higher circles are higher than the energy of the lower circles likewise the switches at the nodes require a constrained power so as to outfit the motion from the past nodes from where the signal is taken. So giving full current to every one of the switches at the point when the signal is taken from simply past SN is unreasonable. Accordingly the energy required by the switches ought to accord the sort of association which they need to accomplish and the likewise on the area space of system which they need to associate. The radio wire utilized for transmission of the signs on account of organize demonstrate is taken to roundabout example and it has been evident that the at first when the signal wave has less range (instance of inward circles) the grouping of the vitality thickness is very high [14]. So the vitality scattered by the signal in the higher length is high.

Taking the instance of the speed of the signal, all together to examine the speed of the signal we take the instance of newtonic mechanics, here as the estimation of speed will be contingent upon the estimation of energy disseminated (lost) by the signal while voyaging. As per the mechanics[15] we have motor type of energy and potential type of energy of the framework. For the most part potential type of vitality happens at the beginning stages also, the active type of energy happens at the focuses where the exchanging happens. This can be demonstrated by a thought of

an examination in which the string is given a heartbeat, it tends to create standing wave at the closures of these nodes and travelling waves when the transmission of the signal happens. By considering this case it tends to be effectively speculated that the speed of the signal will be available at the point when just the travelling waves are created while amid the age of standing wave the wave is expected to be very still position. Accordingly, the energy for the thought of the speed is the dynamic energy. The speed of the signal will be specifically relative to the separation between the nodes as (by implication relying upon the quantity of nodes) and additionally on therecurrence. As the recurrence of the signal place a critical job for deciding the energy of the signal.

Presently taking the case about the radius of circle, then the sweep of the circle in the event of system relies upon the quantity of nodes present over that circle. The range of the n^{th} circle of the particle is straight forwardly relative to the square of the quantity of that circle and furthermore relies upon the quantity of electron present in that circle. Consequently, the range of the circle is directly relative to the quantity of nodes which are available over that circle.

Consider two nodes one in the third circle and other one in the primary circle as indicated by the circle appeared above. The signal from one node should be exchanged from one node to other, for this reason viewable pathway exchange of signal can be utilized however it is control expending and the nodes in that specific system ought to have high goals control. All together to take care of this issue the above model can be utilized which includes the exchanging of the signal from one node to different as being moved in the atom. In the atom, electrons having higher energy travel in the higher circles however as the vitality decline the electrons movements to the lower circle.

In this way, by implication a way ought to be given with the goal that the signal ought to consequently go to bring down circles when required. Too the calculation is created to send the information from one node to another information as energy in efficient manner. As appeared in the figure the signal ought to stream in the way for productive energy utilization. In the figure beneath, three round circles of systems are chosen and if the information must be sent from one node of lower circle to the another node of the equivalent lower circle then the switches associated on the higher circles must not be provided with the power due to which the power can be spared. Same case can be connected when the signal is to be sent structure the SN of the higher circle to another SN in a similar circle (close-by nodes) at that point the nodes on the lower circles must not be provided with power. This connection is connected to the model for the computation of vitality in one circle that is the vitality required for the nodes that comprises our sensors. The sensors on the external circle tend to utilize part of energy. In our model least energy which is required by a sensor organize is appeared.

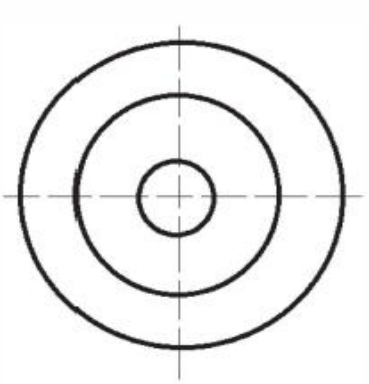

Figure 1: *Defining Three Orbits of WSN.*

From the above figure, efficient way for the transmission of signalis displayed. We calculate the power dissipated by a particular node to move through the arc of a particular nth orbit,

Power = (energy/time)

Therefore, to calculate the time for which signal will flow through nth orbit.
T= D/V
V= speed of light.
D = distance travelled by the signal over the arc.

$$D = (2 * \pi * R * \left(\frac{\theta}{2\pi}\right))$$

Here θ is the angle made by the radial vector with the node. On simplifying we get
D = (θ × R)
c = 3×10^8 m/sec
T = (θ × R)/ 3×10^8 m/sec
Power dissipated for transferring the signal in nth orbit will beP= E/T

$$P = \left[3 * 10^8 E' * Z^2 * \left(\frac{1}{N^2 * \theta * R}\right)\right]$$

Here,
E'= energy dissipated when signal is travelled from the SN on the first orbit to the centre.
N = Orbit number.
θ = angle made by the radial vector of the node of the destination end.
R= Radius of the current orbit.

The given power is the power veered off by the signal , when it will travel θ edge over a circle of sweep R. The estimation of Z will be named as constants and the genuine power will be contrarily corresponding to node number, point and range of the circle. Taking the case that if signal need to exchanged from node n to node m then the power will be the total of the all out power as consumed by the sensor arrange for the transmission of information. Give P_i a chance to be the power required for transmission of information at that point all out power P_o:

$$P_0 = \sum_{i=m}^{n} Pi$$

The model incorporates the idea through which the signal should travel effectively. A few rules of gravitational force are also incorporated into this paper. As in the instance of a space craft so as to reach to certain planet (goal) it tends to rotate other planet for picking up an appropriate speed and increasing speed given by the gravitational energy of the planets. By picking up this energy the space create is well adequate with its energy and can be utilized to achieve its appropriate goal. Similarly the signs from the nodes should go in the energy productive way so the constrained energy sensor system could be utilized with most extreme proficiency. The sensor arrange at each node comprises of receiving wire through which it could make the signal to exchange from one nodeb to other. The way through which this signal energy ought to be exchanged is through indistinguishable path from on account of a space specialty or electron. The signal of one node ought to be connected with nearby node so this signal which could be frail in the mid-way can again be stimulated legitimately.

Considering probability point of view

Consider a little system display with three circles and let number of nodes in the principal circle is four. The probability appropriation will include the probability appropriation thickness of the model and after that it will be considered for a vast system by the estimation of desire for exceptionally high associated system. Let the information should be exchanged from one node to other and the attractive lines leaving Spherical cross section). The likelihood thickness will continue diminishing as the radius of the wave increments.
P(c) α 1/ r
r = radius of the magnetic waves
As indicated over the difference of the radius of circles are trustworthy on the probability ideas, the estimation of the sweep is gotten from the probability. It has been discovered that the quality of the signal is alright to exchange the signal upto the probabilitydensity comes to up to Pc (next segment); this implies the proportional sweep distinction of the

circles is twofold of the separation up to which the likelihood is Pc (as appeared in the figure: 2 & 3).This estimation of Pc has been turned out to be in a perfect world as 0.5, they have incorporated a square grid demonstrate and considered the status of the nodes in the diverse probabilities of the arrange.

IMPROVEMENT IN THE MODEL

By using this model, it tends to be recognized about the most productive approach to exchange the information, which means the calculation for productive node is preferred. Each other strategy that can be utilized for expanding the productivity of the model is making just a single node to be on with power supply and others to be in dozing stage. Some looked for of man-made brainpower ought to be incorporated into the systems for the choice of the nodes for exchanging information. This can likewise be done by coordinating the vitality prerequisites of the arrange (clarified in past research). Additionally, in our work there is some energy pay on the grounds that the likelihood of high associating system is deliberately kept low to increase the life of sensor. From period change techniques, it was found out that the estimation of p is 0.5 yet on the off chance that it is more prominent than one at that point there will be exceptionally associated system. In this way, the effectiveness of just a single sensor ought to be high at once and others ought to be closed with their capacity. Some different strategies can also be effectively incorporated into the model, for example, control disappointment assumption.

The model should work in all parts, in all atmospheres, in all circumstances so the choice of legitimate receiving wire is moreover fundamental. The radio wave weakening is hard to break down inside the structures along these lines half wavelength dipole receiving wire ought to be utilized. In the instance of half wave dipole receiving wire,

E = -20 Log(d)

Where E denotes relative electromagnetic field strength and d is the distance between the transmitter and receiver. This shows the relation between then dissipated energy and the distance up to which it can have a good network connection.

SIMULATION

R tool

For this senarioR tool is incorporatedtopotray the change in Probability to the distance from the SN. PDF and CDF of the framework has been incorporated.

Consider the instance of a WSN having aSN and concentric orbits. Taking the instance of one SN and concentrate has been made with respect to the Probability capacities which are diminishing with the expansion in sweep of concentric orbits. We have considered as the reduction in the Probability is following a diminishing exponential configuration. In this manner, we take the instance of Exponential Distribution.

Here the variables are r and θ where

r = radius of the circular orbit for each node.

θ (p) = exponential distribution function.

λ = constant value.

(Probability Distribution Function)

$$\theta(p) = \left(\frac{1}{\lambda}\right) e^{-\lambda r}$$

So by the exponential appropriation we have the diminishing bend which speaks to the diminishing conduct of likelihood work concerning the range of the circles, additionally it has been found for the situation of CDFwork at first there is a substantial increment in the capacity however after it crosses a specific sweep esteem it ends up steady as one.

$$\theta(p) = 1 - e^{-\lambda r}$$

For λ= 0.8 we have taken the following simulations. X-axis denotes the radius of the orbits.And Y-axis denotes the CDF

probability function.

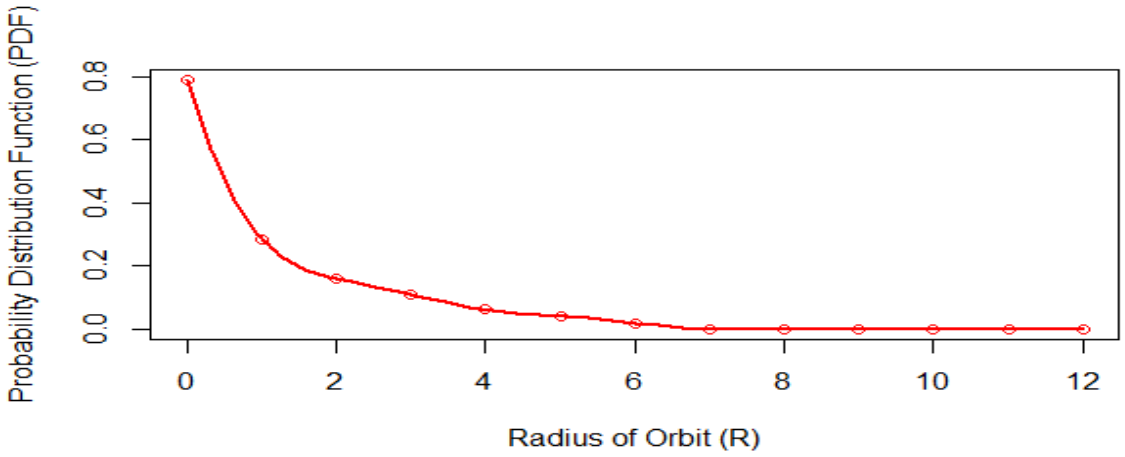

Figure 2: *Distribution of Probabaility (PDF) with Respect to Radius.*

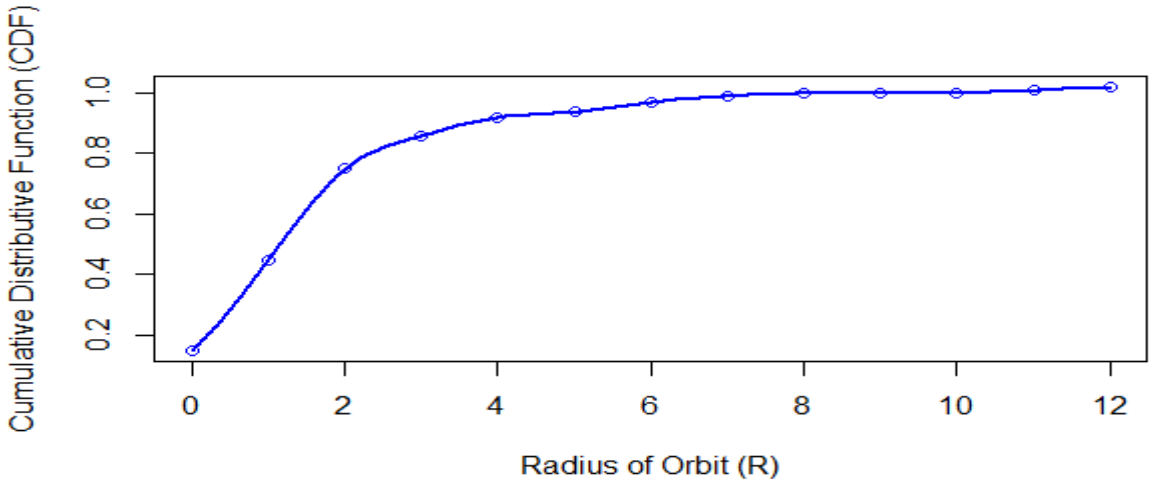

Figure 3: *Distribution of Probabaility(CDF) with Respect to Radius.*

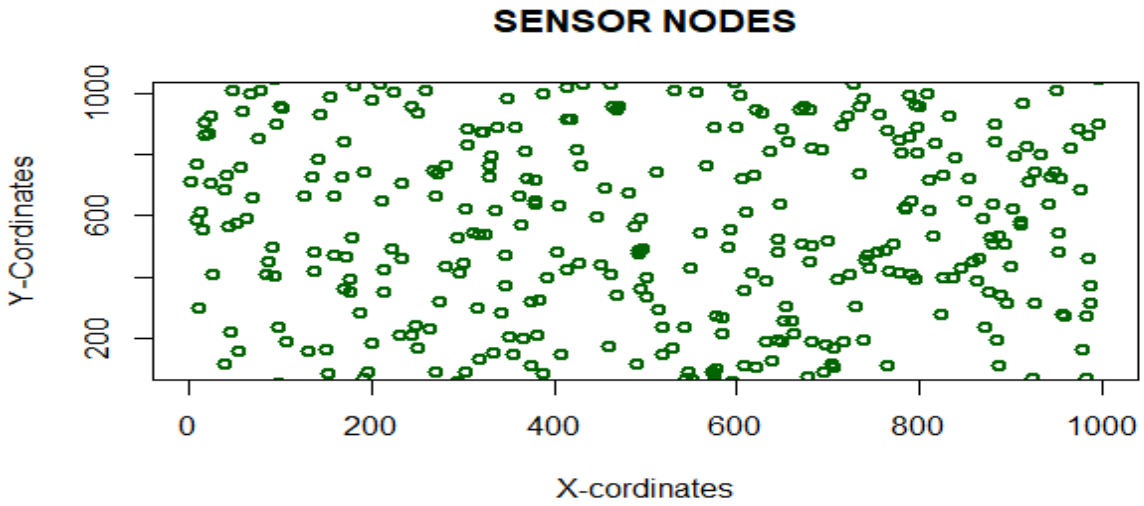

Figure 4: *Graph Representing SN in 1000*1000 Area.*

MATLAB Simulation

MATLAB simulation is also given regarding the connection of Sensor Nodes for transferring the data from one SN to another. In this case total 50 SNs are selected and made to connect if the probability between them for connection is more than 0.5. The SNsare selected randomly whether they are connected or not, simulation is given in figure 4.

CONCLUSION

We have raised the idea of random graph theory for making a model on WSN. This model is based on the concept of Bohr's Atomic Model and percolation theory, which is a kind of random graph whose edges are formed only between the neighbouring SNs. Various environmental setting has been done concerning the use of probability distribution for finding the areas having highly connected SNs.This paper has also included techniques by which data can be routed from one SN to another. An improved model has been prepared in order to make it energy efficient. As the model includes the concept of Bohr's Atomic Model and other concepts of Probability, so a lot of research work can be possible in this area consisting of the development of the energy distribution pattern.

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