Research Square

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Implimentation of Novel Framework For Efficient Data Gathering With Multiple Mobile Sink Sensor Nodes In WSN

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Research Article

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Abstract

In couple of years, the great research towards oceanographic data transmission and submerged impurity the Submerged Wireless Sensor Networks are getting great consideration. SWSN includes issues such as link sustainability, time to begin interaction, data loss due to real-time transmission attempts and transmission range. The aforementioned complications have been approached through different routing configurations, but none of these can handle transmission efficiently. In this paper we proposed a framework of network in depth based data acquisition system with simulation and experimental results. The system model has been efficiently transmit data (Turbidity, Temperature and PH) in a region (Indus River) using the smart cluster sensor nodes and acquires result of 6.5 to 31 N.T.U of turbidity. The experimental results proved that the projected work improves the performance of the data transmission in Submerged Wireless Sensor Networks.

Introduction

Wireless Sensor Networks (WSNs) have been mostly considered as a standout amongst the most significant advances for the next generation submerged sensor network [1–2]. A Submerged Sensor Network (SSN) is a circulated system and it contains countless discrete, self-coordinated, minor, low controlled gadgets called sensor hubs. The SSN incorporates a number of spatially scattered, attractively small, battery-worked, implanted gadgets systematized to steadily gather, process, and pass information to the concerned having confined figuring and handling abilities. There has been a critical measure of innovative work, particularly concerning correspondence upgrades and system framework which have opened wide entrances for the effective data transmission of SSN. Sensor systems can coordinate huge amounts of ease through which wireless transmission in the river is conceivable, best known as submerged sensor network (SSN) [3]. Submerged Wireless Sensor Networks (SWSN) have augmented the extent of uses running from submerged instrument observing, contamination, submerged seismic movement checking, search and salvage tasks and monitoring them for further calculations. Routing is a mechanism of trust based system where data is transferred hop-by-hop [4]. A secure routing procedure handles malicious nodes and keeps the network secure from external attacks also [2, 5]. Structuring and execution of underwater sensor network conventions are confronting various difficulties because of its one of a kind domain what's more, acoustic channel constraints. So, in order to provide high reliability of delivering messages, we need a re-transmission mechanism. Also the declaration discusses that weak nodes do not waste the network resources. Routing manages the transmitting information from Node to getting end. In addition to information transfer, it additionally assumes a significant job in the presentation of the system. An efficient routing technique can provide several advantages to network. Though, major works have been placed on the designing and developing protocol based on the underwater communication characteristic a decent routing algorithm exhausts least vitality by diminishing any overheads in the framework [6–7]. Checking nodes are generally direct appropriated along stream and channel in water system zone, which builds straight circulated WSN [8]. Going for straight conveyed WSN, flooding directing convention dependent on vitality and bounce number (BEH-

Flooding) is proposed. The convention acknowledges effective and stable remote information transferal of water system territory [9]. As indicated by the rule of similar bounce number, hubs are isolated into numerous levels [10]. In all levels, two directing hubs are chosen dependent on the standard of ideal remaining vitality [11]. In the transmission arrange, information bundles are just moved between steering hubs of higher level and directing hubs of under level [12]. By this, the convention has the vigor of flooding convention, yet in addition diminishes additional information transmission [13]. To check a zone with the zone estimations inside the shows are of two sorts, i.e. go based and broaden free. Both sorts of restrictions go under the static focal points with the static centers [14]. The RSSI (Received Signal Strength Indicator) grow the model with the logarithmic model polynomial model, what's more, the Path Loss Exponent (PLE) change model were discussed at that point the PLE were considered as the banner quality sign was overlooked [15]. It is comprising of number of nodes which experiences Byzantine assault. As a result, the network contains a large number of Byzantine nodes. Hence, in a wireless sensor network, the truthful nodes send their binary decisions to the fusion core, while the Byzantine nodes send fictitious messages. Then, in order to detect the existence of misbehaving nodes in the network, use binary hypothesis testing in combination. Then, on the receiver operating attribute curve, measure the nodes' operating points. [16]. The quality of the sign not steady and that shows more prominent variety and influences the presentation of the system. It broadens the procedure in the light of RSSI for using the characteristics for division estimations [17]. The paper will be utilized to work the strategy in an equipment foundation of the Zig Bee. According to this paper, another 3D weighted centroid restriction calculation is presented from investigation for hardly any broad techniques, and it gives a superior accuracy level to limitation [18–19]. Each of the method of data forwarding in each round has not been considered by any study before as most of the existing work of routing protocol suggests changes in the ranges of protocols while the path remains unattended. The communication for the wireless network requires a reliable device, those devices are Xbee modules which are cost affective and good in performance. The sensors for data acquisition of continuous time are mostly in analog in Wireless Sensors Network.

In this paper, we introduce a novel solution of efficient data collection and forwarding on the basis of their performance parameters. Hybrid routing protocols were implemented in SWSN with full degree of success and perform better than two known methods flat and hierarchical routing protocol. The transmission performances of all routing protocols were done and the model for hybrid routing is proposed with algorithm and experimental setup.

The paper is structured as follows. Section I introduces the literature review of data transmission in SWSN. In Section II present the experimental setup and performance parameters. In Section III we proposed the algorithm for efficient routing. Section IV discusses the operation of data collection and forwarding. Section V deliberates the techniques used in our system. Finally, Section VI summarizes the results and discusses applicability and limitations of our approach.

Real Time Testing Model

The design provided the projected progressions for the development of the expressively enhanced hybrid routing protocol. The proposed submerged network contained 3 cluster nodes in a motion area of 30 m x 30 m. A node is well-defined as the minimal practical element of a network and is included of a power source, a controller, sensor/actuator for assembling data, and a wireless module. As an element, the node suffers energy reduction of its internal battery as a result of sensing, processing, data transmission and reception. So for that a non-stop source of in outline of an adapter is used. The nodes collect the sensed and processed information from the sensors and transmit them to the base station for the analysis. In the proposed model of hardware framework of network are defined as Transmitting Modules and Receiving Module. The transmitting Module collects the data from a water and delivers it to the Receiving Module which is connected to a Computer to monitor the data. The proposed model of sensor framework comprises of correspondence units of water parameters estimating the sensor data. The correspondence unit includes Xbee modules. The Zigbee Module is to use to impart neighboring sensor system. The Zigbee gadget furnishes the remote availability to gadgets with low power utilization made by Standard (DIGI Xbee, 2017). The Circuit board consists of Turbidity Sensor (Tsd-10), pH Sensor kit and Temperature Sensor (Ds1B820) as shown in Fig. 1. The data from Turbidity Sensor and PH Sensor is carried out in analog form and digital from Temperature Sensor.

Turbidity is defined as darkness or dimness of a liquid brought about by colossal quantities of discrete spots that are frequently undetectable to the unassisted eye, like smoke in air. The approximation of turbidity is a key probationary of water quality. It is measured by Tsd-10 Turbidity Sensor. Temperature is a significant factor to think about when surveying water quality. Although its own belongings, temperature impacts a few changed parameters and can adjust the physical and mixture properties of water. It is studied by Ds1B820 Water temperature senor. Though all water contains some degree of radiation, the sort and sum are reliant on an assortment of variables. The pH of pure water is 7. In universal, water with a pH lower than 7 is measured acidic, and with a pH greater than 7 is considered basic as shown in Fig. 2. This degree of measure is studied from pH Sensor kit.

To design the dependable hardware, it is necessary to use the components with good image in market and have availability so the user will have system in very cost effective way. The description of each component in this Network is described in the Table 1.

Table 1
Description of Hardware Components

Manufacturer Part Number	Description	Units
Tsd-10	Water impurity testing	Count per volts
DSB180	Water temperature calculation	Count per volts
PH Sensor Circuit	Calculation of water quality testing	Count per volts
PH Sensor Probe	Water sampling for PH calculation	-
XBEE Modules	Trans-receiving Communication	802.15.4 RF
DC Adapter	5V DC Power Source	Volts
Arduino UNO	Controller	-
Computer	-	-

Algorithm Process

This algorithm is used in each node to perform Software modeling and simulations. This algorithm is made to make sure that the system is consuming low power according to our resources.

In process of the entire system, the beginning is based on parameters reading. The correct and accurate data is responsible for data forwarding. The checking of readings of parameters decides the data to be forwarded. Sleep mode makes the system save power also the checking of sleep mode decides the rechecking of parameters when the sleep mode is completed as shown in Fig. 3.

The sensor hub comprises of the wake-up collector and the information transmitter. The information transmitter doesn't start except if the wake-up collector recognizes the wake-up signal from the cluster sink node. The wake-up signal receiver monitors only a specific band. At the point when the output of the packet recognition surpasses the edge value, the inward force supplies the unit capacity to the information transmitting module.

Algorithm for Routing

1. Start
2. L← length
3. W← width
4. No: of Nodes← n
5. No: of Rounds ←R
6. ~net
7. [1….. n]

8. Π [L] [W]
9. net = net1
10. subplot 231
11. ⊕ (net↔2)
12. ⊕ (net ↔3)
13. For
14. i = 1 and nume1 = net (1)
15. **loop**
16. j = 1 and nume1 = (net)*1
17. X1 → net (n, i), Y1 → net (3, i)
18. X2 → net, Y2 → net (3, j)
19. j = xSide → abs(X2-X1)
20. k = ySide → abs(Y2-Y1)
21. d = {Σ (√j^2, √ k^2)}^1/2
22. d = [i….. n]
23. **if (d < R) && (i = j)**
24. A = vertices1 → [X1, X2]
25. B = vertices2 → [Y1, Y2]
26. ⊕ (**A** ↔ B) & (W ↔ 0.1)
27. Hold on
28. End Function
29. End For
30. End

At the point when the information transmitter begins, every hub haphazardly chooses one sets of MPOMS (Modified Pseudo Orthogonal M-Sequence). Additionally, the information bit "1" and "0" of the detecting information is communicated by the MPOMS (Modified Pseudo Orthogonal M-Sequence) pair. At that point, one of the sub-transporters that checked the wake-up signal is utilized to transmit the detecting information. On the off chance that various carriers or codes are utilized from different hubs, the node obstruction that awakens simultaneously is diminished orthogonally.

The monitoring network architecture in Fig. 4 includes proposed nodes data transmission mode. The data of the (N) nodes in the group is gathered into BS (Base Station) by Xbee. Then the collected data in BS is monitored. The nodes N1 and N2 transmits its data through q1and q3 to node S, and then node S transmits its own data together with the data received from q1 and q3. Finally, all the nodes transmit data to the substation BS. Considering the communication time of RF system and the sharing mechanism of

wireless channel, the delay of data transmission from substation to control center can be neglected, so the total delay ti of group is described as

BS= (q1-1) + (q3-1) + (q2-1)

$$\text{Route} = qit_n + qit_s + 1/V_y \sum_{k=1}^{ri} \sum_{k+1}^{ri} \quad (1)$$

Where t_n represents the time delay of channel t_s is the transmission time of the RF system, ri is the number of nodes of group, and V_y is the communication speed of Xbee. Eq. 1 contains three parts. The first part represents the channel access delay, the second part represents the transmission delay of the RF system and the third part represents the transmission delay of the nodes [20].

Processing Of Hardware And Software

The processes of network are mutually based on connection of Xbee modules and Software configuration. The connection of Xbee modules is set to have for immediate delivery of data. For utilizing that feature the connection of one Xbee to another Xbee is based on API mode which is one of the configured mode of Xbee. API Mode is generally used for the continuous data transmission and the network I mostly based on the analog parameters studies that makes API mode the vital part of processing. In Xbee here is configuration freedom for user. The user can make its own compatible settings according to respective work. For optimization of network the general preferences of Xbee are set on 1000 ms for Guard time operating modes of transmission and the command mode character limit is set on 2B in Hex. The Xbee Modules in Transmitting and Receiving Modules are identified as “Coordinator” (Receiver) and “Router” (Transmitter). These identifications are done on the individual configuration of both Xbee Modules. The entire configuration of Modules is done on XCTU Software. The Modules are assigned for their PAN ID. The both modules have same PAN ID in order to identify themselves while data transmission. The configuration of “Router” is set on transmitting the data on its highest range of broadcasting address of matching PAN ID. For recording the data and for receiving the data from a dedicated port, it is necessary to apply addresses in code for getting accurate and authentic data. In connections of Serial Communication, each receiving data has its unique address. In Xbee, they have designed a dedicated forms of addresses of their ports and for reading the data using controllers like Arduino, they have set up a manual for users to check the address and apply it in code of Algorithm in order to monitor data. As we have used 3 Pins of Xbee, AD1, AD2 and AD3, all three has slightly different addresses. Addresses are mapped in this sequence MSB (Most Significant Bit) + LSB (Least Significant Bit) where both bits are of 1 Word (2 bytes). That’s how data is formed by these addresses. As of address, the ADC Port of Xbee has one address portion in which all pins of ADC port has a dedicated address with a slight change. For ADC port the portion is consigned for address is 0x04. For exploring more addresses assigned in this port like A1 = 0x04, A2 = 0x05 and A3 = 0x06. For AD1: MSB + LSB = 0x04 = 0000 0001, for AD2: MSB + LSB = 0x05 = 0000 0010 and for AD3: MSB + LSB = 0000 0011. Each address bit is of 2

bytes. For getting the 2 bytes for 1 bit, the algorithm will be applied for checking and writing the data in 21 rounds of getting data. Now the connection of Arduino to Xbee is another major part of processing of network. This connection is base for data receiving, data calculating and data monitoring. The connection between Arduino and Xbee is a serial connection. This connection method is used in many of wireless devices such as Bluetooth and GSM modules. The 0 and 1 pins of Arduino are interfaced with Xbee's TX and RX. That's how a connection is made for data receiving. The Algorithm installed in Arduino for Routing uses serial data for monitoring the data.

Experimental Software Setup

The experimental Algorithm is installed in Proposed Hardware Model. The algorithm is based on C language which is identical in Arduino language. The work of Algorithm is same as the simulation results shows in MATLAB algorithm code. As discussed in earlier chapters that how a Xbee is calling the address to get the desired data, the algorithm is also using that addresses from the I/O ports of Xbee to get data in Serial connection and the it is calculated and the data is printed on computer screen and User can see data. The flow of code is same as the algorithm of simulations. The simulations algorithm shows the number of turns in network with respect to the dead nodes and the experimental algorithm shows the actual data in real time applications. Turbidity Sensor is calculated in (2).

Turbidity = Analog*(5/1024)*100 (2)

The code starts and initializes the devices. Then it verifies the PAN ID, if the PAN ID is matching then it forwards the code otherwise it rechecks the PAN ID. After verification and identification of PAN ID, the address is checked if it is coming from correct and authentic I/O port of Xbee or not. This work is done with the help of serial data. PH Sensor data is calculated in (3).

PH = buff [k] = Analog Reading (LSB+ (MSB*256)) (3)

After the address is correct it reads the received data and then calculates it according to the equations given in data sheets of the sensors. For example the data for Water Temperature data is calculated in (4).

Temperature = (Analog LSB + (Analog MSB*256)) / 1024 *(1.23) (4)

After calculating the data, now data is printed in Serial Monitor feature in Arduino.

Routing Techniques In Swsn

In wireless sensor network, the hubs gather information furthermore, transmit it in the framework with sink as the goal. The hubs in Wireless Sensor Network have the ability to legitimately send the information to the sink, yet this correspondence requires high transmitting force vitality, and vitality is a significant issue in WSNs; in this manner, it is required to transmit information with vitality effectiveness. To transmit the information all the more effectively regarding vitality, a multi-jump way is chosen to

advance information rather than direct correspondence. The source hub may choose the following bounce statically or progressively, that is, with the assistance of pre-framed steering tables or utilizing specially appointed sending. This next bounce advances the information with sink as the goal. After a way is picked, the information is sent to at last arrive at the sink with greatest unwavering quality or least postponement or then again most extreme security. Flat routing convention is a system correspondence convention executed by switches in which all switches are each other's companions. Flat routing convention circulates directing data to switches that are associated with one another with no association or division structure between them. Hierarchical routing is the methodology of orchestrating nodes in a hierarchical way. A good illustrations are to consider a corporate intranet. Most corporate intranets comprise of a fast system. Associated with this spine are nodes which are associated with a specific work gathering called Sink Node. Hybrid Routing Protocol (HRP) is a system routing protocol that joins Distance Vector Routing Protocol (DVRP) and Link State Routing Protocol (LSRP) highlights. HRP is utilized to decide ideal system goal courses and report organize topology information changes. Here are two routes in system for the transmission of data in comparison with Flat and Hierarchal Routing. Routing protocols structure is done by three types of routing. Every Routing Protocol has its own operation and properties. The three Routing Protocols are given as under. In Flat route the data travels from Node 1 (N1) and goes towards Sink Node (S).

And then finally computer (C) receives it. In Hierarchal there is another Node called Sink Node (S) which receives data from Node 1 (N1) and Node 2 (N2) together and shifts towards Computer C. In hybrid Route the algorithm of nodes is set for backup data receiving. If there is any error in this channel (N1, N2, S, C) then it follows this route (N1, S, C) to avoid disturbance in receiving data as show in Fig. 5. According to our design of Node framework these parameters can be studied in order to examine the performance of different routing as shown in Table.2

Table 2
Comparison analysis of various routing

Parameters	Unit	Flat	Hierarchal	Hybrid
Speed	m/node/sec	1.2	> 1.2	3
Depth	m	3	> 3 or 5	> 3 & < 6
Distance between nodes	m	5	7–10	> 10 & <16

Results

To evaluate the performance of the network, the framework was investigated by flat and hierarchal and hybrid routing. The results from the experimental setup are presented the sensor network scenario by static cluster nodes. Here we use the number of dead nodes metrics to analyze and compare the performance of the protocols. Figure 4 clarifies the numeral of dead hubs per round in a flat algorithm.

Considering different solutions with every node connected to every node, or on the other hand if each node was associated with sink node, shows the suitability of hierarchical routing. Convolution of network topology is decreased by it, proficiency of networking nodes is increased, and, causes substantially less blockage on account of less routing displays as shown in Fig. 6.

The attributes of an underwater remote sensor arrange (SWSN) for the most part require organization of various sensor hubs to screen an item, domain, or occasion. With the utilization of appropriate directing conventions, the life of a SWSN can be expanded much past the life of any of its individual hubs by putting the hubs in rest mode when not being used and actuating a solitary hub at any given moment in a specific inclusion zone with numerous hub organization. In view of the system topology in which the WSN steering happens, the steering convention can be delegated level, progressive, area based, or direct as shown in Fig. 7.

The simulation statistics from Fig. 8 illustrates the initialization of route. The routing signal uses dead nodes to set the path and then start taking rounds which increases simultaneously, after this number of rounds increase quickly.

The simulation informations from Fig. 9 shows the next stage in hybrid route. The signal now demonstrates the stability of rounds furthermore, the quantity of dead nodes. Here number of rounds are stable and the signal do not uses the dead nodes further the connectivity of network becomes firm.

Figure 10 displays the final stage which is delay. Stage 3 decides whether the network condition to be completed or the regeneration of link. This process makes the route more efficient.

Figure 11 shows the count per round for hybrid protocol. Result shows that the maximum dead nodes are up to 35 and completes more than 2000 rounds of the network. By this routing protocol, better results are received as compared to flat and hierarchical. Signal selection and signal head check are arbitrarily created dependent on the edge work model, which has great randomness. Cluster head count changes are shown in 11 in the range of $0 \leq k \leq 40$ as number of dead nodes and $0 \leq k \leq 6000$ as number of rounds.

The performance of the routings (Flat, Hierarchal and Hybrid) are shown in Fig. 12. Flat and hierarchy route is a bit unstable in order to form rounds on the network. The hybrid route makes better rounds than other but it uses more number of nodes. Moreover, hybrid route is stable in forming the rounds and the rate of dead nodes is less that other routes that makes it efficient route.

We investigated that due to motionless condition of sink, it is in the center of network, stability period of protocols increases as it has equal distance to all nodes, same amount of energy is consumed. If sink is on upper of network, the nodes which are at greater remoteness from sink will die quickly. The consumption of energy in nodes is more at greater distance so die earlier. The life time of network only increases in hybrid routing protocol because less traffic load is enables to nodes and decreases the delay in communication.

Conclusion

Efficient data transmission in SWSN has always been the focus of research. The performance of network in simulations and real-time experimental was done for 2 nodes in 10 m used to sense an environment, collect data and forward the handled data to the base station. Focusing on the issue of conventional flat and hierarchy protocol, the paper proposes an algorithm with working technique that uses improved routing protocol discussed in experimental equations. The result shows that the hybrid routing will be more accurate and efficient in data collection and forwarding. Using SWSN, hybrid route were transfer with speed of 3 m/node/sec in distance up to 15 meters.

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Funding (information that explains whether and by whom the research was supported)

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Conflicts of interest/Competing interests (include appropriate disclosures)

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Not Applicable

Code availability (software application or custom code)

Not Applicable

Authors' contributions (optional: please review the submission guidelines from the journal whether statements are mandatory)

Not Applicable

Ethics approval (include appropriate approvals or waivers)

Not Applicable

Consent to participate (include appropriate statements)

Not Applicable

Consent for publication (include appropriate statements)

Not Applicable

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Figures

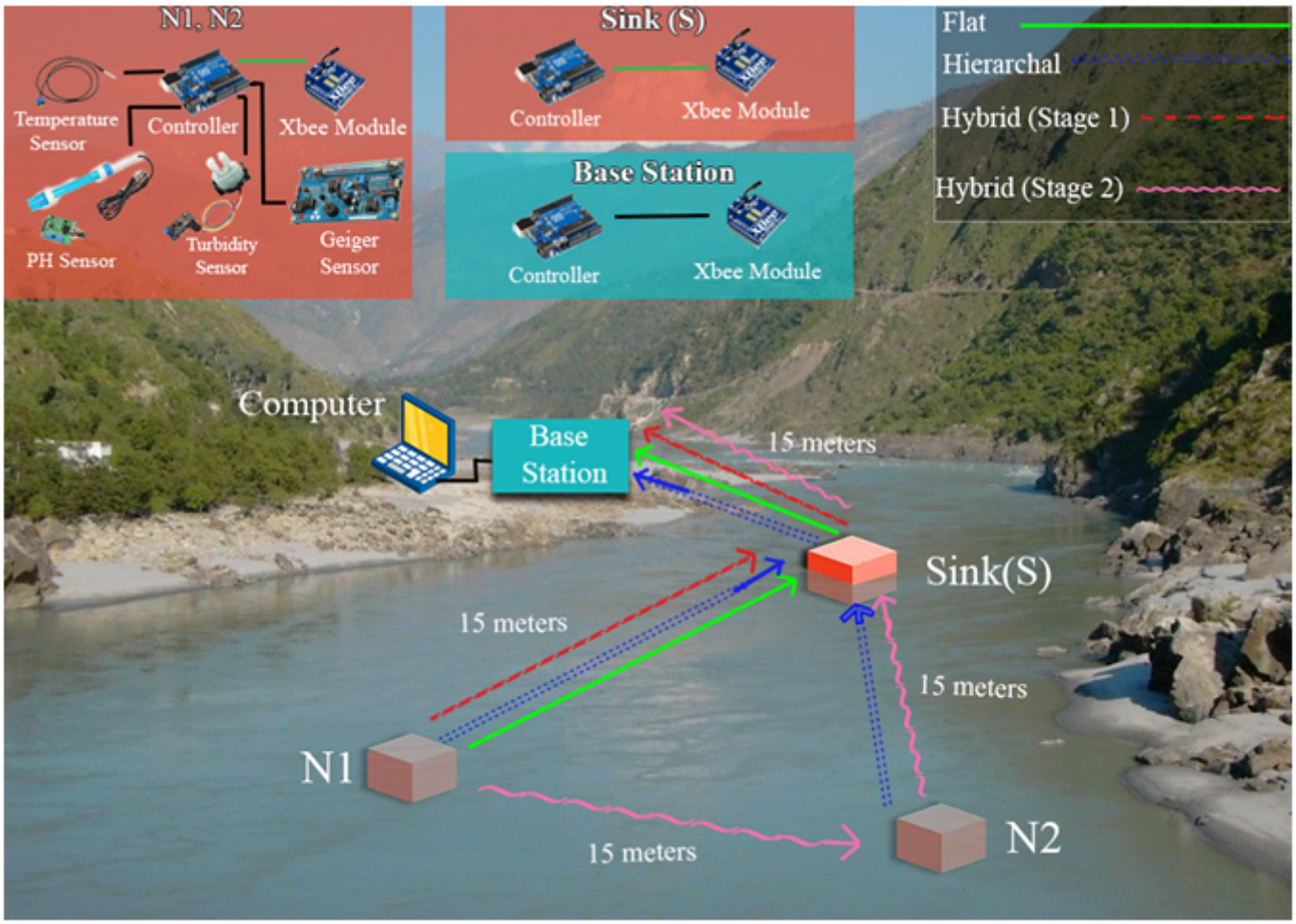

Figure 1

System Model of Network Framework and Operation

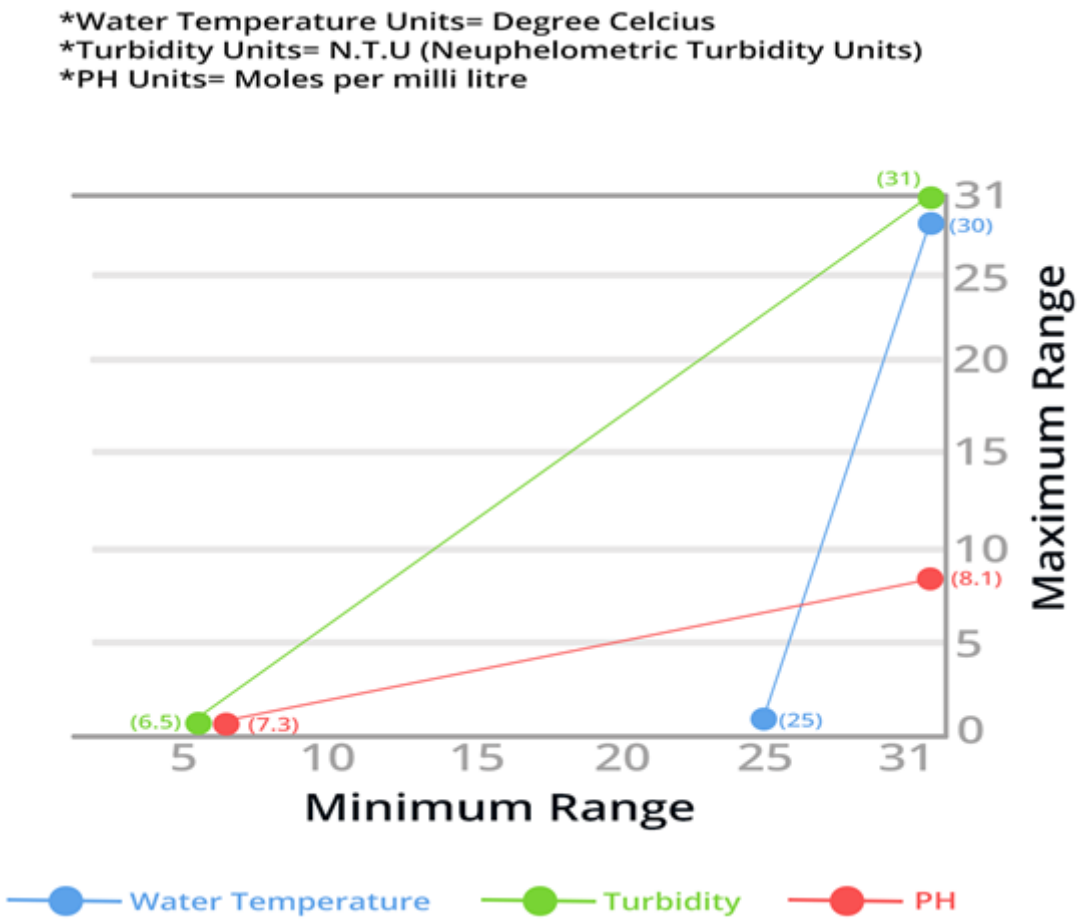

Figure 2

Ranges of values in Water Parameters

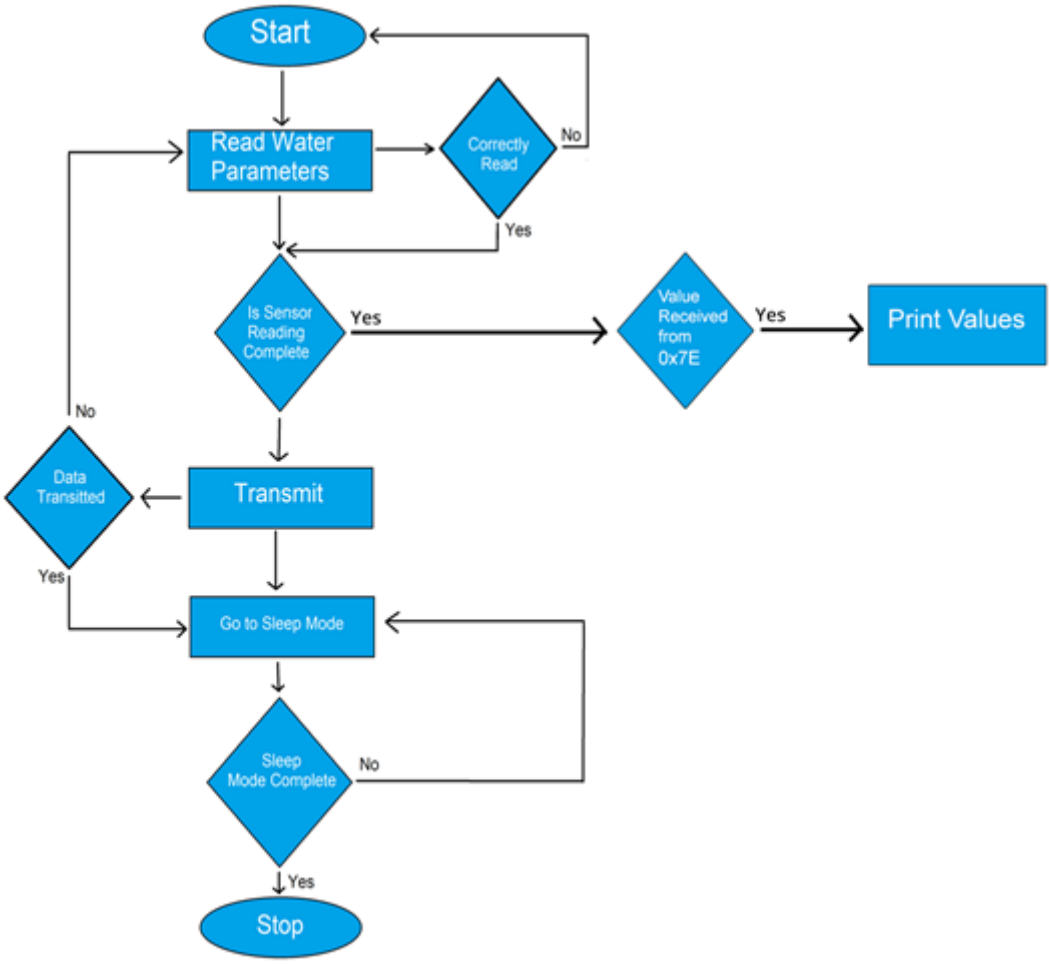

Figure 3

Flowchart of Algorithm in Network

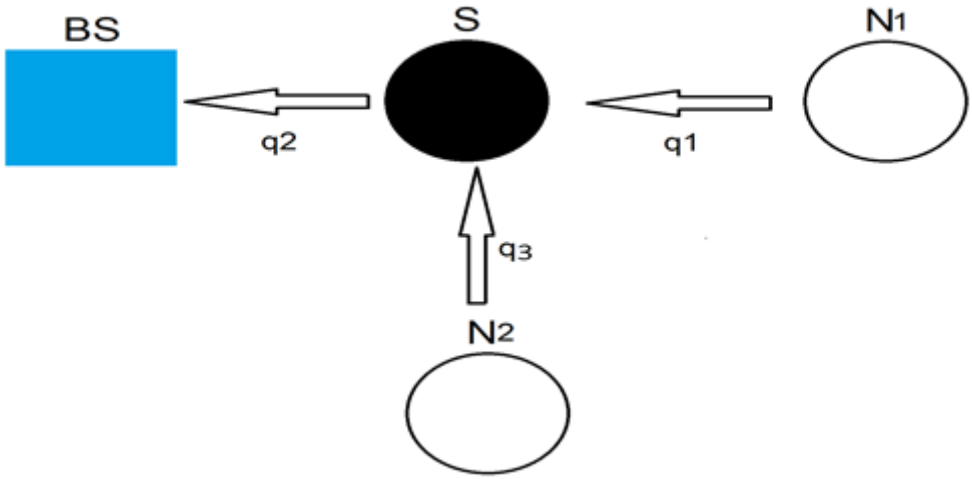

Figure 4

Mathematical Process of Algorithm

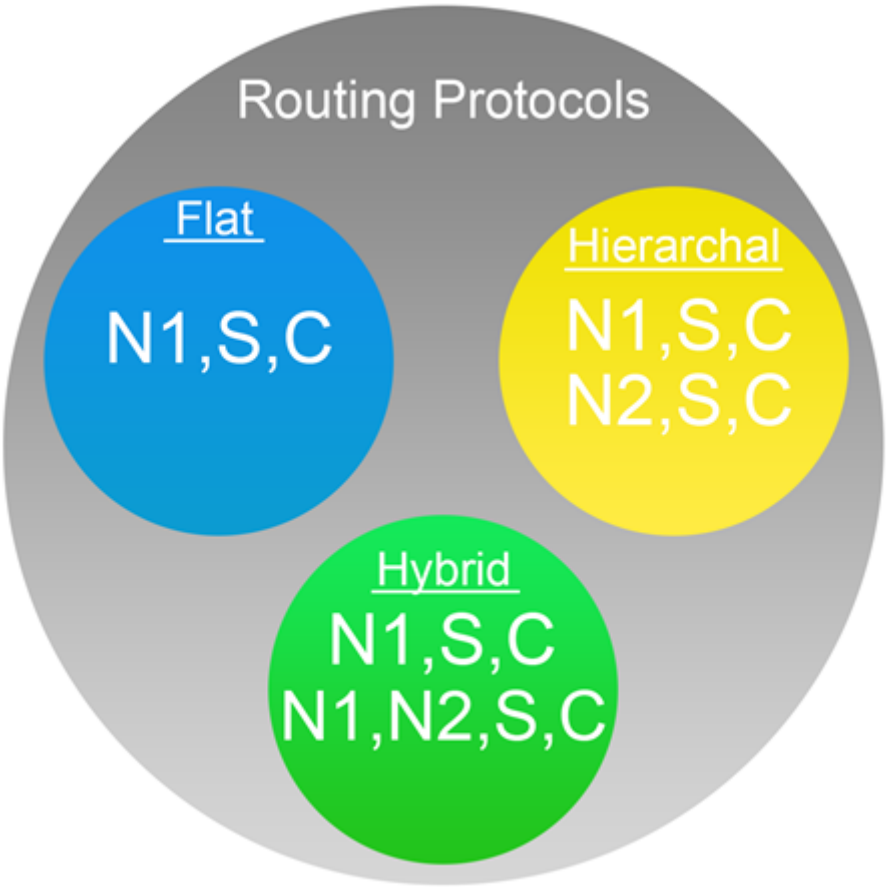

Figure 5

Routing Protocols Structure

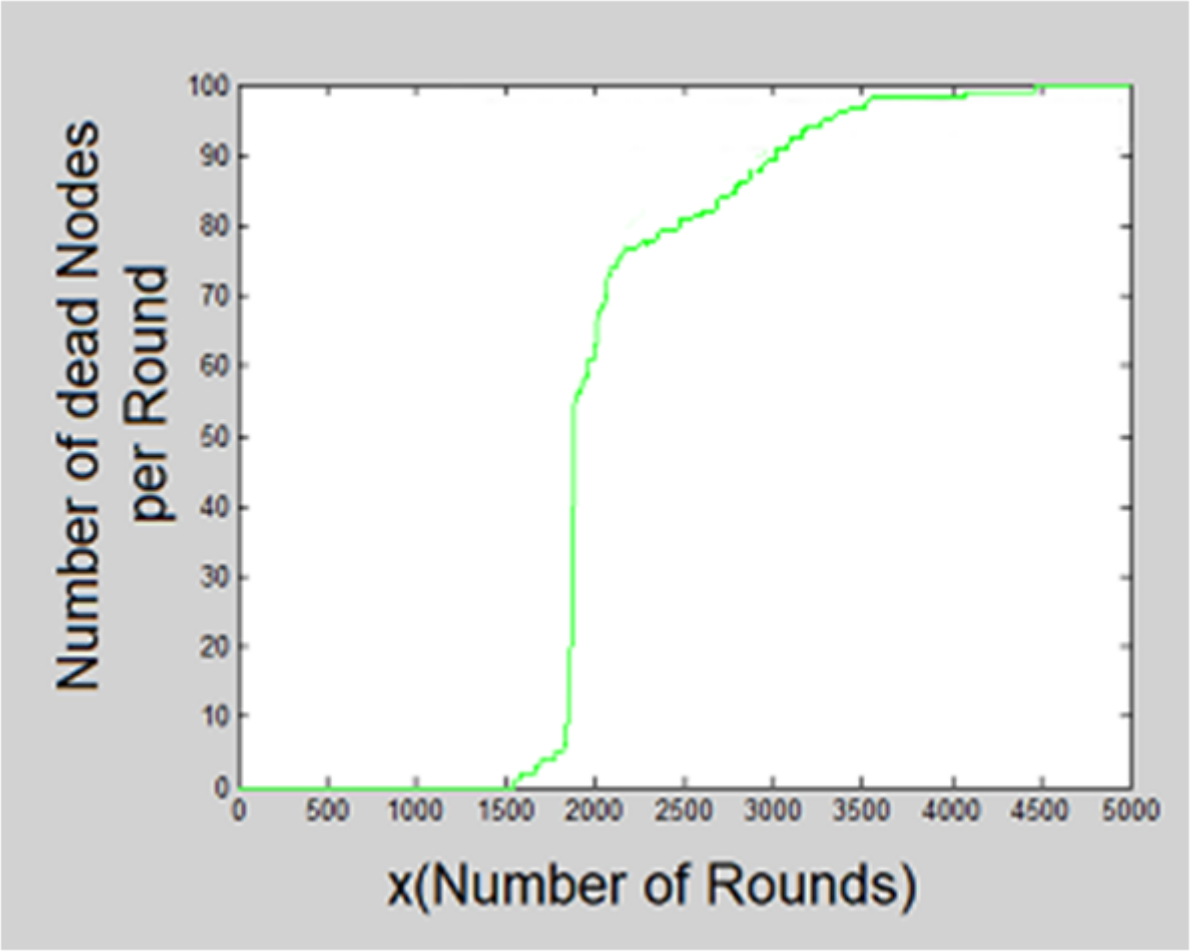

Figure 6

Nodes dead during round in Flat algorithm

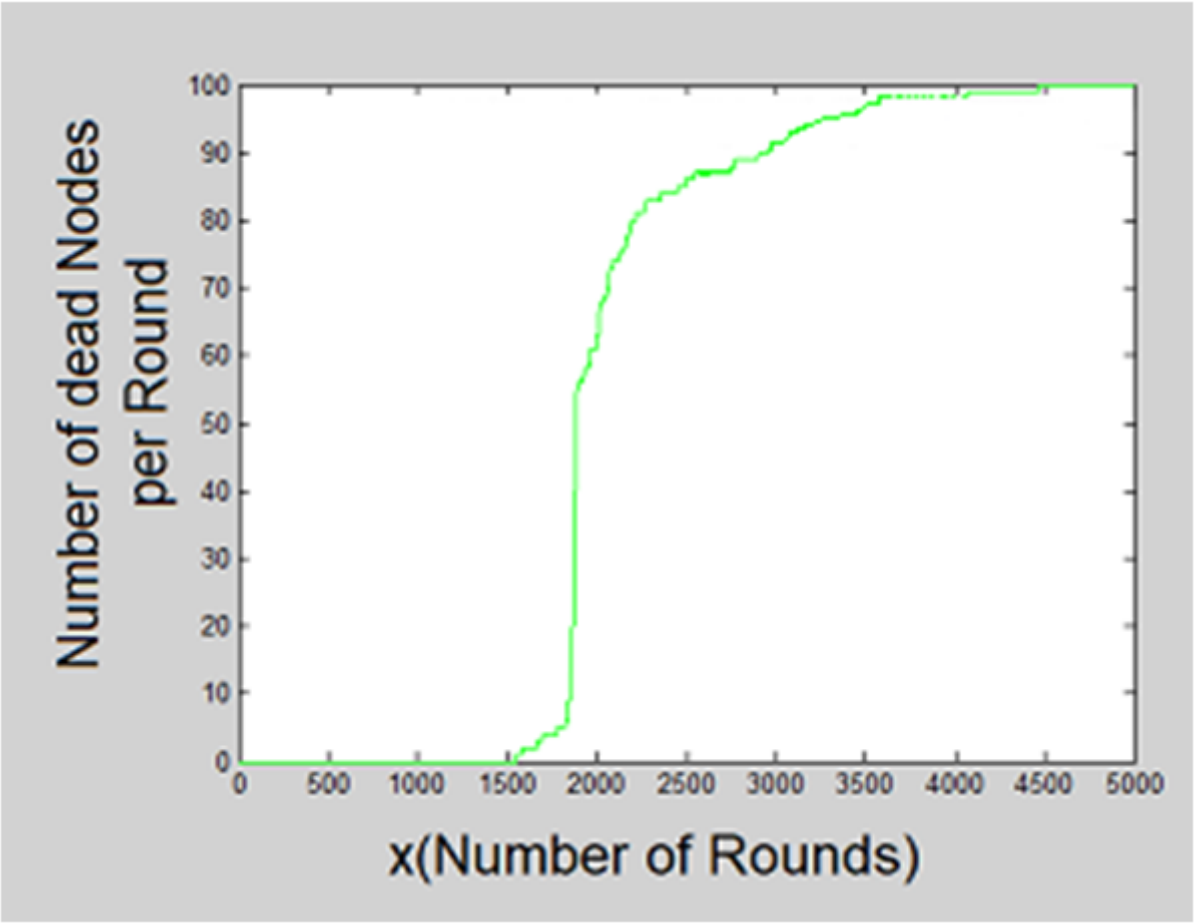

Figure 7

Nodes dead during round in Hierarchal algorithm

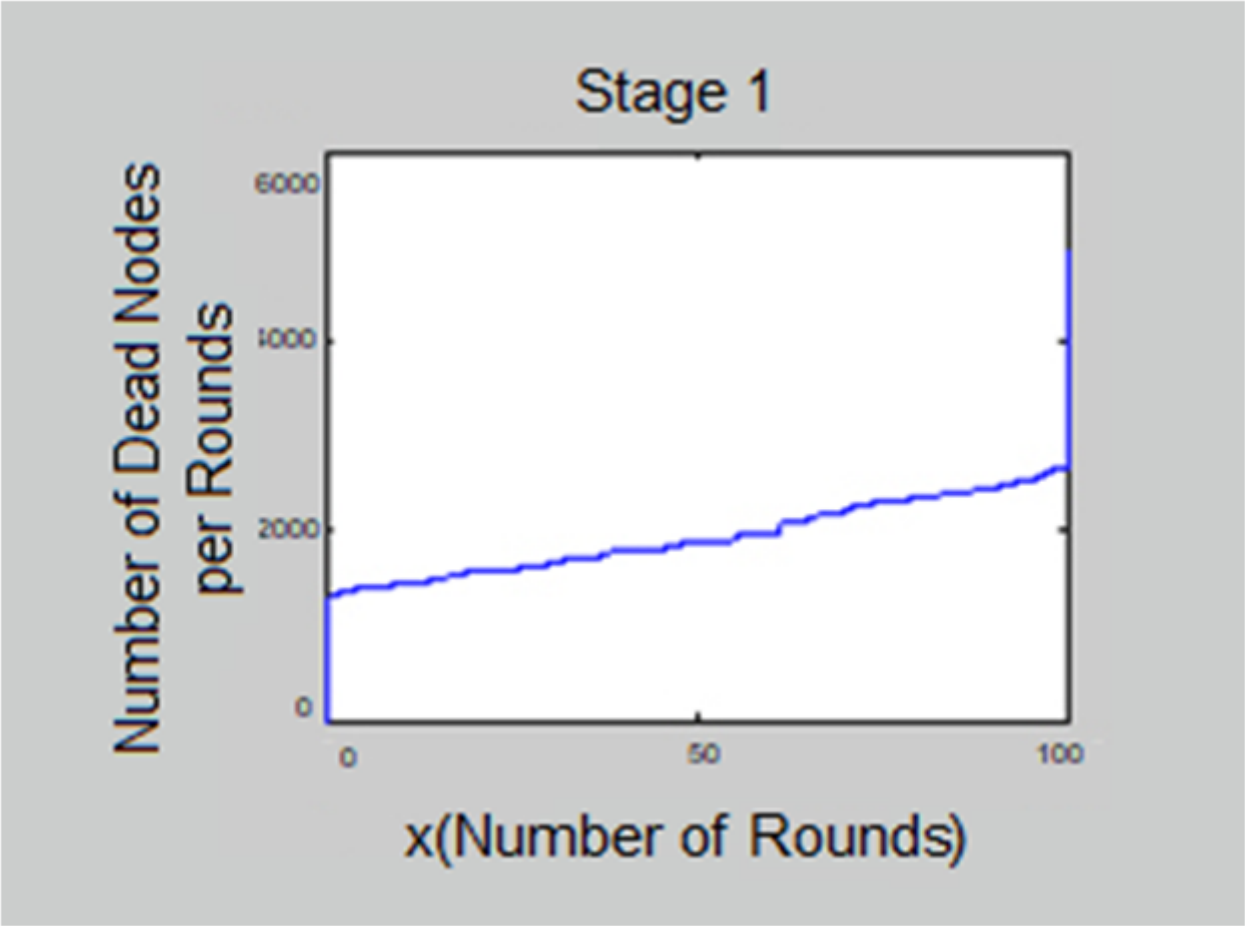

Figure 8

Stage 1 of Hybrid Routing in SWSN

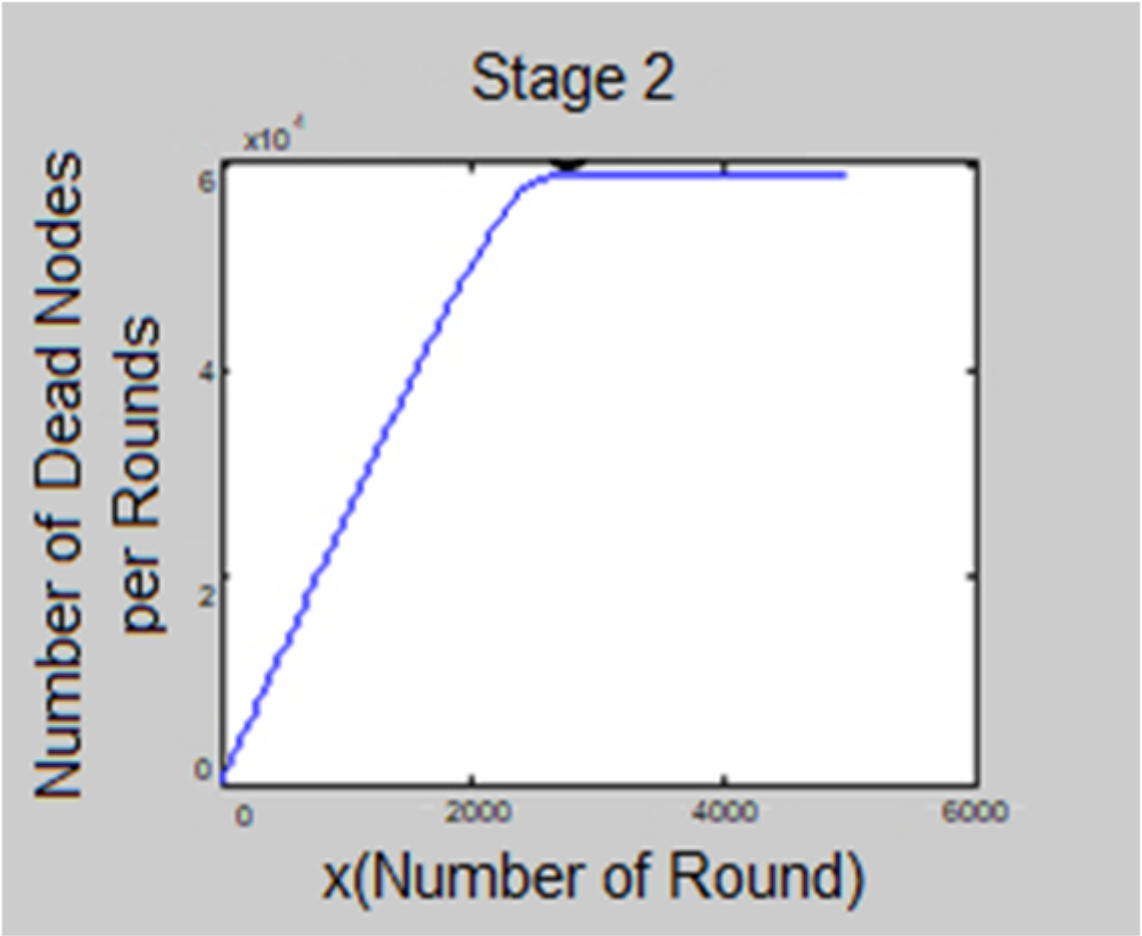

Figure 9

Stage 2 of Hybrid Routing in SWSN

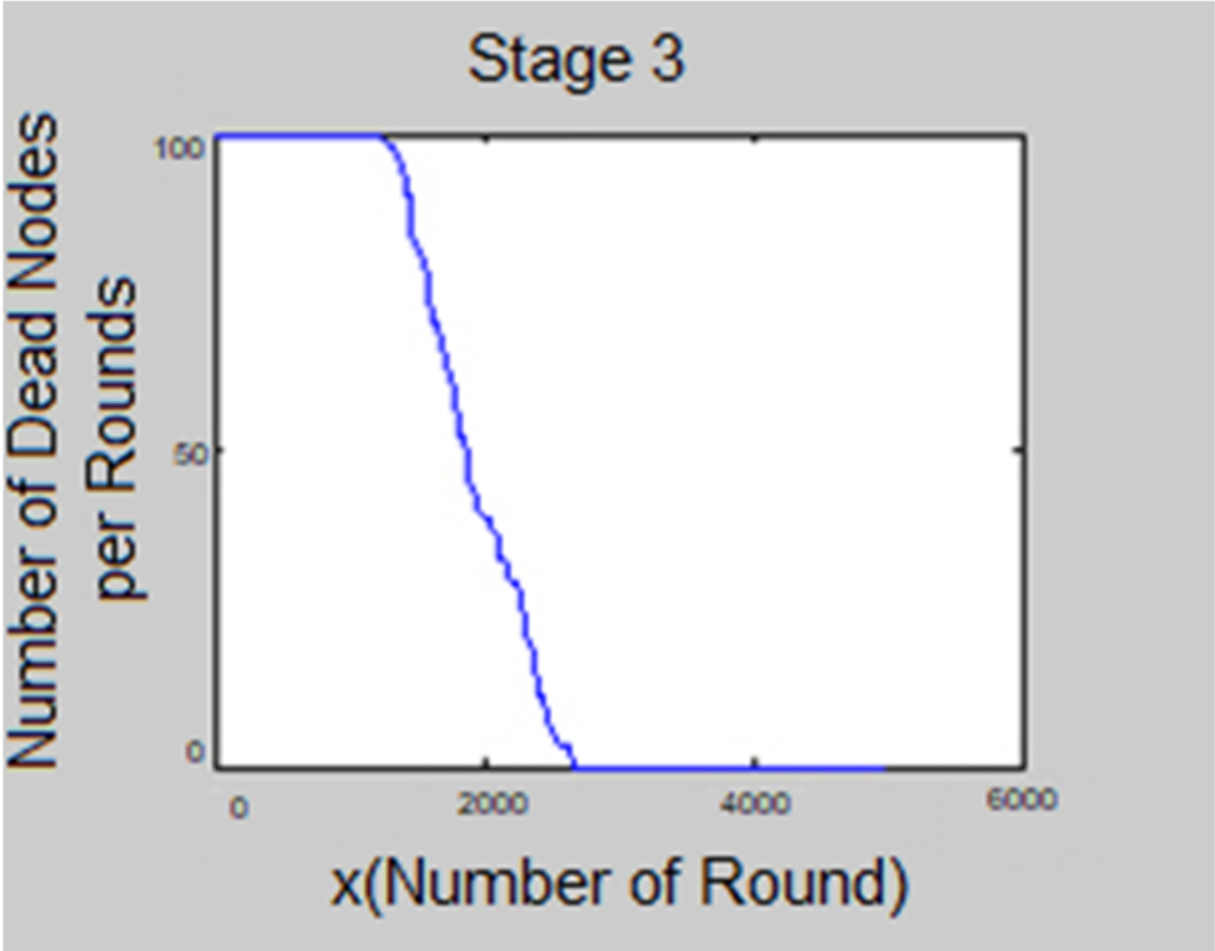

Figure 10

Stage 3 of Hybrid Routing in SWSN

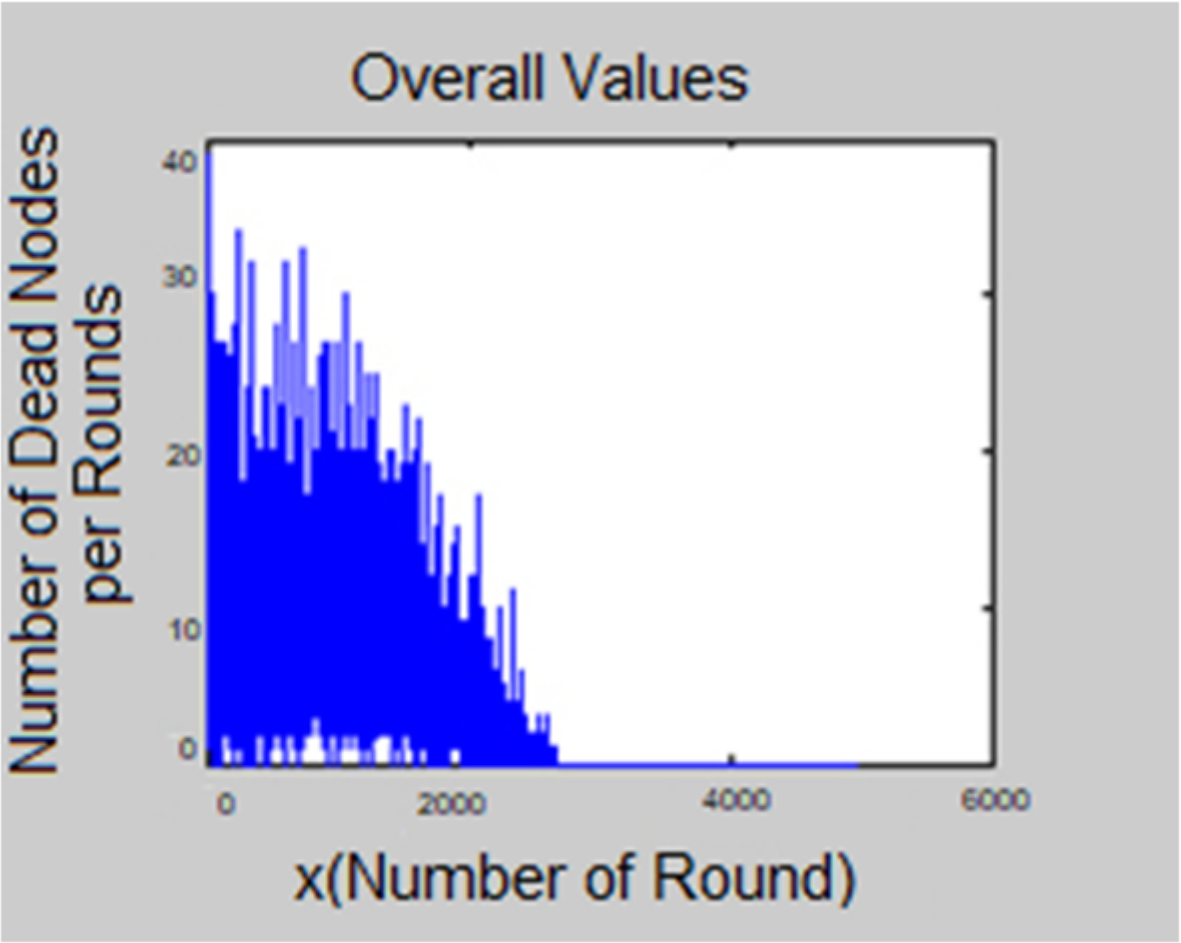

Figure 11

Overall values of Collected Hybrid Routing in SWSN

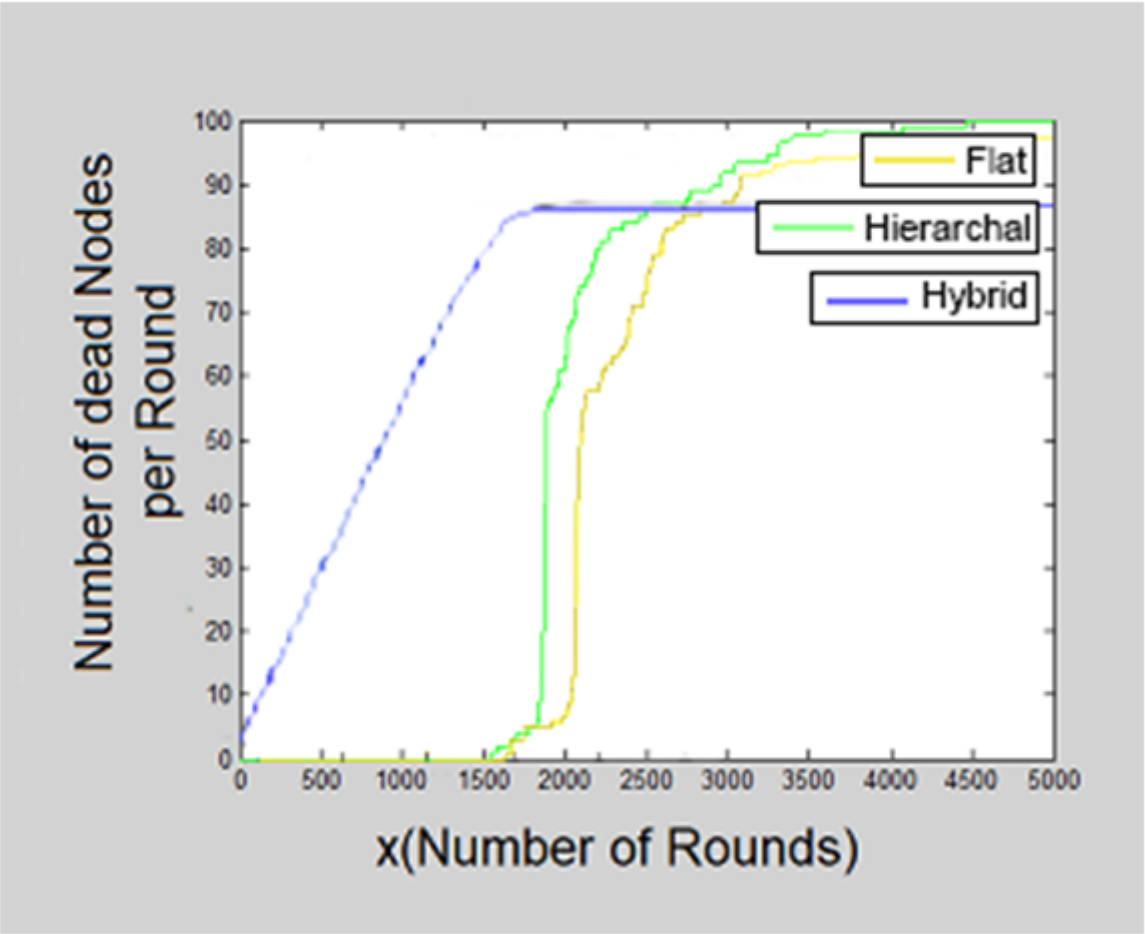

Figure 12

Comparative Graphs between Routes