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An Efficient Under Water Communication Using Hybrid Low Energy Adaptive Clustering Hierarchy Protocol

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ABSTRACT

Wireless sensor networks are fast-growing in the communication field because of their compact size and ability to work in rugged conditions. The basic operation of the wireless network is the systematic gathering and transmission of the sensed data to the network controller center for further processing. Autonomous Underwater Vehicle (AUV) has been proposed that moves backward and forward along the pipeline and collect the information from the sensor node gathered by the surface sink. In turn, the surface sink transmits the data to the Network Controller Center (NCC) by using nearby technologies available in that area. While collecting the information from the sensor node, it may cause energy consumption, and the delay get increases. To overcome this energy consumption and delay, the Hybrid Low Energy Adaptive Clustering Hierarchy (H-LEACH) protocol has been used to select the cluster head by using threshold conditions. H-LEACH considers the residual and maximum energy of nodes for every round. Further experimental results demonstrate to reduce the higher energy consumption and the delay while transferring the data.

Keywords: *Autonomous Underwater Vehicle, Hybrid Low Energy Adaptive Clustering Hierarchy, deployment algorithm.*

INTRODUCTION

At present, most pipeline sensors are connected using wired networks. Wired networks are either copper or fiber optic cables. The wired networks are usually connected to regular sensor devices that measure specific attributes such as flow rate, pressure, temperature, sound, vibration, motion, and other important attributes (see Fig.1). The wires are not used for communication only but also transfer electrical power to different parts of the pipeline system to enable the sensors, actors, and communication devices to function. Power for the pipeline resources and networks can be provided by different sources like Solar Energy, Pipeline Flow Energy, and other External Energies.

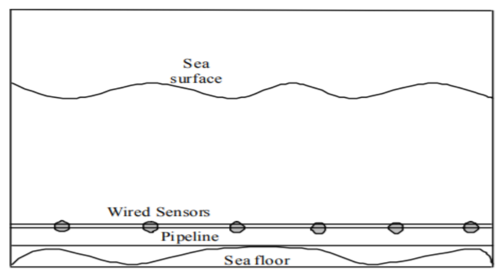


Fig.1 underwater wired sensor network

Wireless networks can solve some of the reliability problems of current wired network technologies in pipeline systems. For example, wireless sensor networks can still function even when some nodes are disabled. Faults in sensor nodes can be easily tolerated by using other available nodes to cover the faulty ones. Using dense sensor networks with a high number of nodes and/or using a wide acoustic transmission range, the network can maintain connectivity, and the sensed information can be transported through the network to its destination even with some node failures.

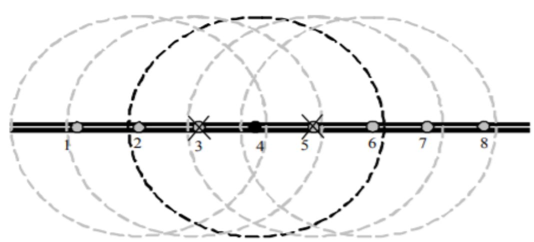


Figure 2: Reliability in dense sensor Networks

Neighborhood nodes can communicate either using wired or acoustic communication. The transceivers in the normal case are turned off, and the wired network is used for communication. Therefore the connectivity of the network is through the wired links in the normal case. Each node periodically checks the status of the right side of the network wire by sending echo messages to the neighboring nodes on the right. Each node also periodically checks the status of the left side network wire by receiving/replying to the echo messages received from the neighboring node on the left. A break of a wired link between two nodes can be discovered by the left node when it does not receive replies for the echo messages it just sent. The break can be discovered by the right node if there are no echo messages received from the left node. When both nodes discover the break, they will activate their transceivers and communicate through the acoustic link. This wireless acoustic link between the two nodes can provide connectivity for the pipeline network, and sensed information can still be transported through the network, as shown in Figure 1.6. The nodes that discovered the break will report it and the location information to the NCC for immediate maintenance. If an intermediate node is disconnected from the left and the right, the node can operate temporarily using the rechargeable battery until the wire breaks are fixed.

An autonomous underwater vehicle (AUV) is a robotic device driven through the water by a propulsion system, controlled and piloted by an onboard computer, and maneuverable in three dimensions. This level of control, under most environmental conditions, permits the vehicle to follow precise preprogrammed trajectories wherever and whenever required. Sensors onboard the AUV sample the ocean as the AUV moves through it. Providing the ability to make both spatial and time-series measurements. Sensors data collected by an AUV is automatically geospatially and temporally referenced and normal of superior quality. Multiple vehicle surveys increase productivity, can ensure adequate temporal and spatial sampling. Furthermore, provide means of investigating the coherence of the ocean in time and space.

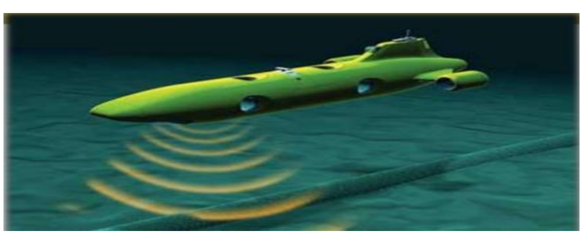


Figure 3: Autonomous underwater Vehicle

Autonomous underwater vehicles fall into the mobile robotics sector and are of brilliant importance to the present world military and commercial requirements. The need to find a cutting edge in military research induces the invention of AUVs.

An autonomous underwater vehicle (AUV) is a robot that travels underwater without requiring input from an operator. AUVs constitute part of a larger group of undersea systems known as unmanned underwater vehicles, a classification that includes a non-autonomous remotely operated underwater vehicle. Controlled and powered from surface by an operator pilot via an umbilical or using a remote control. In military applications, AUVs are more often referred to simply as the unmanned undersea vehicle.

II. RELATED WORK

Maroua Abdel hafidh et al. [1] proposed a hybrid clustering algorithm based on K-means and Ant Colony Optimization (ACO), called K-ACO, to improve the WSN Lifetime. Efficient energy consumption is imperatively required to maintain the continuity of the network and to allow an adequate interconnection between sensor nodes deployed in the harsh environment.

MutebAlsaqhan et al. [2] presented the work of developing a low- complexity, power-efficient, scalable node for linear wireless sensor networks. The developed system is intended primarily for water pipeline leakage detection applications. This work mainly tackles the communication part of the system.

Adnan Nasir et al. [3] presented a human-centric cyber-physical framework architecture of our in-pipe water monitoring and feedback system. This system comprises the physical water distribution infrastructure, together with the hardware and software supported intelligent agents for water allotment, leak detection, and contamination spread control.

Ahmed M. Alotaibi et al. [4] Proposed an energy-efficient cooperative scheme for a group of mobile wireless sensor nodes deployed inside the pipeline. The nodes are supposed to run cooperatively in order to save their resources. It is assumed that only one node shall remain active for a specific period while all other nodes are in sleep mode. As soon as the active node completes its cycle, it goes to sleep while its timer triggers another node to wake up and continue the process.

Meenakshi et al. [5] designed to reduce the propagating delay and to allocate channel in optimal relay node selection by using a heterogeneous network. In underground pipeline communications, sensor nodes detect the signal and forward it to the relay node, placed above ground.

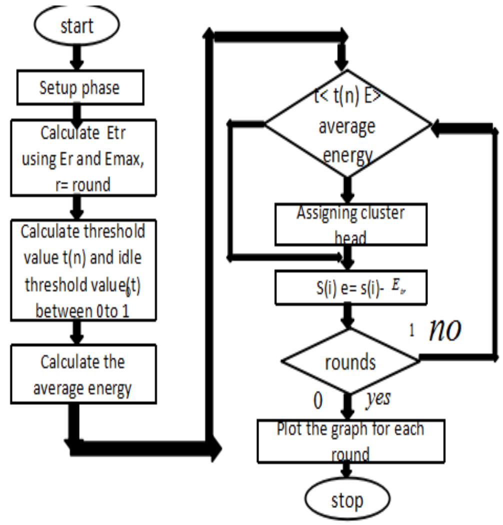
Ayadi et al. [6] investigate various leakage detection formulations based on WSN to identify, locate and estimate the leak size. Besides, a computerized technique based on the analysis of pressure measurement in the water distribution system is presented to find the defective pipe.

III. PROPOSED WORK

In the proposed system, sensor nodes are placed along the pipeline that senses the underwater data at the end of the sensor nodes surface sink is placed. Here the AUV that moves along the pipeline in the backward and forward direction and collects the data from the sensor nodes. Before transferring the data, we are going to apply a hybrid low energy adaptive clustering hierarchy algorithm (H-LEACH) is used to select the cluster head to solve the energy consumption problem. H-LEACH considers residual and maximum energy of nodes for every round while electing a channel head using threshold condition.

HYBRID LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY ALGORITHM

The proposed algorithm is used to find the lifetime of the nodes in terms of rounds. When the proposed threshold and energy conditions are considered. The nodes with energy less than that of the (Etr) minimum energy required for transmitting and receiving signals is made to die as it lacks the energy to do it. Etr is subtracted from the energy of the nodes S(i).e in every round that much energy is consumed. A total number of the alive nodes are calculated for every round to have a track of the lifetime of the network. When the network enters the setup phase. Ep, the probability of using energy considerations is calculated by using Emax, Cp, and Ep, then the average energy of all the nodes are calculated. Then the threshold value is calculated. A number is randomly picked in the range 0to 1. If the number picked is less than the threshold value and the corresponding node is assigned to be cluster head, its energy is more than that of the average energy. The energy required for data transmission is deduced from the energy of the nodes in every round. When the energy falls below the minimum value, it is declared to be dead. H-LEACH(hybrid low energy adaptive clustering hierarchy) deals with the sensor lifetime and energy efficiency of the network. In this LEACH protocol and HEED, the protocol is the hybrid, increasing the period. As these periods will raise the lifetime of the sensor is also rises. The H-LEACH algorithm is used to extend the lifespan of the network based on energy consideration. The algorithm is considered the remaining extreme energy of the nodes.



ALGORITHM 1: *hybrid-low energy adaptive clustering hierarchy*

1. Intialization:N=(n1,n2,n3…,nn), E=(e1,e2,e3…,en),r=number of rounds, Ech=energy of channel head,e0=initial energy of each node, Eavg= Average energy of all nodes in a particular cluster, Ep= probability using Energy consideration, Er=remaining energy, Etr= energy required for transmitting and receiving data, $E_{\max}$ = maximum energy of a node, TDMA=(Time Division Multiple Access)
2. Inputs: Er, Emax,n,r,e0
3. Outputs: CH, graph plotting alive nodes
4. $E_{avg} = \frac{\sum_{j}^{n} en}{n}$
5. I=1 to r
6. If(ni€N) then
7. e0(i)=P*(($E_{\max}$ - E_{used})/ $E_{\max}$)
8. t(n)= (e0(i)/)1-e0(i)*mod(r, round(1/e0(i)))
9. t=random number (0-1)
10. if((t<t(n)) && (ei> E_{avg})) then
11. CH $\leftarrow$ ni
12. S(i).e=s(i).e- Etr :used o send information through TDMA
13. End if
14. i= i+1
15. go to step 6
16. plot total alive nodes for each round
17. end if

Lines 1to 3 describe different parameters used in initializing the code, inputs, and outputs of a system. Line 4 describes the average energy used, which is used later to compare the energy with other nodes and derive a second channel head that is used to send information to a base station using the TDMA mechanism.

Line 5 describes energy constraints used to determine the probabilistic value that is used to obtain threshold in the later stage. Line 6 initiates the end terms of a loop process for the max number of rounds. In Line 7, the initial energy of each node is set. Line 8 considers threshold values that are used to estimate the channel head of a node. Line 9 considers a random number between 0 to 1 and compares it with a threshold value to determine the channel head. Line 10 is checked if the random number picked is less than the threshold and the node has enough energy to transmit data. Line 11 indicates the assignment of the first channel head. Line 12 describes reducing the Etr from the energy of the node. Line 13 and 14 increments the process to the next round. Line 15 starts the whole process again from line 8. Line 16 indicates the plotting of a graph between alive nodes and the number of nodes.

CLUSTER HEAD DATA TRANSFER

Here cluster head is used for communication to the base station, and a radio model analysis is carried out to send the data. Transmitter sends the information to an amplifier, and then it sends it to the receiver. Distance between transmitter and receiver is used to evaluate the performance of hopping distance among the nodes.

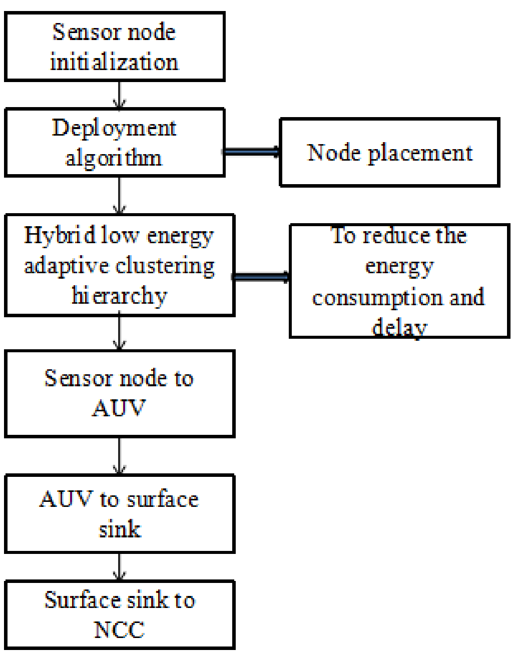


FIGURE 4: FLOW DIAGRAM

SCHEDULING PACKETS

TDMA is used to schedule packets from channel head to base station. The process is carried out once it receives all the nodes from normal nodes, and every specific packet has a separate slot to avoid congestion in the network. Here energy using transmission and receiving is considered with a photon's energy, bit rate, and transmission.

SINK-TO-NCCLINK:

For the link between the sink and the NCC, use any of the media to long-range protocols that are available in that particular region. Such protocols include cellular, TDMA, CDMA, GPRS, LTE.

NODE DEPLOYMENT:

To maximize the Network Lifetime of the deployed LWSN along the pipeline, it is important to find the adequate placement of sensor nodes and define the efficient distance between them.
The deployment algorithm places the sensors in their position inside the surface of the pipeline. The sensor nodes are equipped with a magnetic part to fix them inside the surface of the pipeline. The coverage, the transmission range, and the maximum permitted number of sensors (n*) are the three main constraints that should be used, as expressed below.

$$\max NL = \frac{E_0}{\max_{i=1}^{n}(E_i)}\ timestep$$

IV. RESULTS

V. CONCLUSION AND FUTURE WORK

Underwater pipeline monitoring is among the areas where WSNs have a great effect on their supervision. An AUV moves back and forth along the pipeline to collect data from sensor nodes when it comes within transmission range, and then the data are transferred towards the surface sink and network controller. In this work, a hybrid low energy adaptive clustering hierarchy has been used to reduce energy consumption. In the future optimized algorithm is used to reduce energy consumption and delay.

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