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Enhanced Underwater Balanced Co-operative Routing Protocol

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Abstract: Underwater wireless sensor networks (UWSNs) is an developing area for research in the wireless sensor networks (WSN) area. The normal method is to adapt for underwater use presently accessible terrestrial architectures and well-proven architectures. Underwater Wireless Sensor Networks (UWSNs) have drawn a lot of concentration to help multiple applications such as tracking pollution, tsunami warnings, offshore exploration, tactical tracking, etc. For many applications, the efficiency and reliability of the network in terms of high performance, energy conservation, low bit error rate (BER) and reduced delay are prerequisites. However, UWSN's unique characteristics such as low bandwidth available, big delay in propagation, extremely vibrant network topology, and high probability of error pose many difficulties in the development of effective and reliable communication protocols. Therefore, in this proposed work, along with its mathematical model, we suggest a protocol that focuses on improving network reliability and effectiveness through cooperative routing and sink mobility. For reliable data transmission, cooperative transmission is well known. Based on their residual energy data and depth , prospective relay and target nodes for cooperative routing are chosen in this algorithm. Data from the source node is transferred in a cooperative way to the target node via the relay node. Mobile Sinks collect information straight from the nodes of the location. We consider as selection parameters the depth threshold of the source node, the residual energy of the destination nodes/ potential relay and the SNR of the relating source node to the potential relay / destination node. In this work, two distinct selection criteria for partner nodes are also introduced and contrasted. Partner node selection (relay / destination node) for cooperative routing should be carried out on the grounds of a certain criterion in order to achieve efficient outcomes. Based on the extensive simulations carried out in MATLAB, we note that our suggested method increases performance in terms of energy efficiency, network life and decreases BER relative to the existing depth-based routing protocols.

I. INTRODUCTION:

The oceans are made up of two third part of the earth. It has received a lot of significance from the previous couple of years in the study view. UWSNs are used for various applications in water, such as tracking various regions for safety surveillance, tracking pollution and sensing particular resource regions, such as oil extraction, etc[1].

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To make these apps feasible, communications between underwater devices need to be enabled. The main difficulties related to underwater applications are given as below [2],[3]:

i. a large delay in propagation, that is in the terrestrial setting about five orders of magnitude greater.
ii. In nature, the channel is dynamic, particularly due to multi-path fading.
iii. Higher bit error rates and temporary loss of connection may be encountered because of vibrant channel features.
iv. Battery power limitation and typically non-rechargeable, and solar power can not be used as well.
v. Sensors underwater are susceptible towards pollution and corrosion failure

UWSN is a self-ruling sensor hubs system that are spatially allocated underwater to detect particular issues. The stationary or mobile sensor hubs are remotely connected to exchange various occasions of intrigue through correspondence modules[4].It is possible to classify a large amount of UWSN applications as tracking apps. Examples of environmental monitoring include assessment of water quality, pollution surveillance (biological, chemical, and nuclear), monitoring of sea currents, fish or micro-organism tracking, measurements of pressure and temperature, and assessment of conductivity and turbidity [5].Thus, in the view of various ongoing applications of the underwater wireless sensor networks, the reliability of the network is one of the major issues to be discussed.

II. RELATED WORK:

In[6], the authors have concentrated on ideal clustering for UWSN(underwater wireless sensor networks) compliant with any of the wave-based wave communication methods of FSO (free space optics) , acoustic and electromagnetics .Besides, they suggested a d generacy model for energy of sensor nodes in Free Space Optical and communication grounded on Electromagnetic wave sand compared it with the present-day degeneracy model of energy for communication based on acoustics. In specific, the appropriateness of the three above-mentioned underwater communication methods is explored and the authors compared their efficiency based on consumption of energy and ideal clustering. In [7], UWSN study is performed on the underwater communication channel, environmental variables, location, media access control, routing protocols, and communication effects of packet size. They compared available methodologies and addressed their pros and cons for further enhancement in underwater sensor networks to highlight fresh study directions.

In [8], the authors created a routing protocol to address the issues in UWSNs, in this scheme the authors have used the fuzzy logic inference scheme for determining the suitability sensors for transferring packets to the target.

The suggested protocol is contrasted in the works with a typical routing protocol in case of mobile networks of underwater sensors. The experimental findings confirm that the suggested work is effective and feasible. In [9],the authors proposed a protocol based on current DBR protocol. Routing in DBR depends upon the size of the nodes, i.e. nodes taking not as much of depth works as taken by forward nodes and consume extra energy in comparison to other nodes. Thus, nodes which are closer to sink will die first due to increased load. Cluster-based(CB) strategy is used in coDBR. For reducing consumption of energy, load is allocated equally between all nodes. Each node's energy consumption is used equally as each node has the same chance of being chosen as a Cluster Head (CH).This enhances DBR's network stability period. In [10], A new WSN load balancing, routing protocol called the Cooperative Balancing Routing Protocol (CBR), has been suggested. Cooperative Balancing Routing Protocol looks onward through chosen routes, then selects the route that minimizes the energy consumed taking into consideration the nodes ' remaining power. Nodes therefore having capacity to make precise choices for balancing consumption of energy at the time of routing phase, thus, prolonging the lifetime of the network and reducing the partitioning of the network. A model is provided and outcomes are contrasted with three associated routing procedures: CLB ,EAR, and DGLP, and the experimental findings demonstrate that the proposed protocol improves WSN's lifetime by huge percent. In [11], Relay selection system for the cooperative underwater acoustic network based on propagation delay is suggested. In [12], the optimum amount of relays is selected based on evolving conditions underwater. The delay in propagation amongst the relay nodes is taken as a criterion for selecting relay partner. In order to obtain further improvements in outcomes, SNR is further added to the measurement method. In [13], cooperative routing is introduced and evaluated on the network layer along with sink mobility. Based on their depth and remaining energy information, collaborative routing nodes are chosen. When a node is in the locality of MS(Mobile Sink), it will forward its information straight to MS in a cooperative way. While information is forwarded to cooperative partners of a node in the lack of MS. In [14], CoDBR(Cooperative Depth Based Routing) is suggested to achieve data reliability and efficiency throughput. Potential cooperative routing relays are chosen based on their corresponding depths. Source node data is jointly transmitted via relay nodes to the destination node. It improves the performance and decreases packet drop relative to the non-cooperative DBR. In [15], Authors indicate that linking effectiveness can be enhanced by implementing asynchronous cooperative transmission for three-dimensional UWSNs. In this work, two typical transmission systems are also implemented, analyzed and compared. In [16], consider a cooperative system from a physical layer to a network layer with a design element. It results in effective operation and reduces the complexity of the transceiver. It improves reliability by offering gains in diversity through intermediate relay nodes. In [17], the authors proposed a protocol for depth-based routing (DBR).This protocol doesn't want sensor node location information. As an alternative, it only requires local depth data, which can be readily acquired with a cheap depth sensor that can be fitted with any node underwater. An important benefit of the proposed protocol is that without seeking the aid of a localization facility, this one can handle network dynamics efficiently. In addition, this routing protocol could get benefit of an architecture of a multiple-sink underwater sensor network without additional costs.

III. METHODOLOGY:

Here in our work, we are using cooperative routing protocol for improving the overall performance of the nodes which are placed underwater for various applications.

Cooperative Routing Protocol for Underwater sensor networks:

Algorithm A:

Formation of cluster:

A I-level clustering hierarchy is used to reduce energy consumption. And it even more adaptable to change in network & environment. It can quickly react to network topology changes and reconfigures cluster. Routing algorithm is distributed, and nodes can take decision on own for efficient routing. Cluster formation is divided into three phases.

Phase1: Election stage

In this stage, we have consider I ≥1 stages of cluster head and k unique selection and association phases, LLC originates by choosing I =1.

The symbols used in the algorithm are shown in Table 1.

Table1: Symbols used in The Algorithm

Symbols	Explanation
N_0	Total number of nodes
S_i	The group of node swallowed to involved to the *i* th level election
N_{ji}	The j^{th} node € S_i
E_{ji}	The residual energy of Nji power level
P_{ji}	Probability that Nji participate to election phase
R_w	The transmission sweep at the w-th transmission control level
τa , τb	The timer value of the node

Process:

Step.1 every node sets the no. of selection messages obtained by candidate node.

Step.2 .m at 0 and creates a homogeneously spreaded random values u between 0 and 1.

Step.3 compared with threshold Pji defined in (2).

Step.4 when P_{ji} is previously mentioned, node turns into a candidate cluster head and contributes towards election phase; else, that continue to be quiet till the election process ends .

Step.5 Node is empowered in a commencement m old beginning from the esteem τ_a

Step.6 every candidate node transmits the advertising message having P_w (transmission power) that covers a spatial vicinity of R_w radius.

Step.7 every applicant hub gathers the promoting messages originating from the different competitor hubs in the region and additionally tallies the gained messages by expanding m

Step.8

When time τ_a finishes, candidate set the promotion timer to τ_b , where τ_b is function of the number of acquired messages m and the node residual energy.
Step.9 lastly, when τ_b finishes, candidate timer node turns into a cluster head at i^{th} level, and then transmits an advertising message having transmission power P_w.
Step.10 Alternatively, when the timer remains counting down as well as node obtains an advertising message, that disturbs the promotion timer and wait for the election process termination.
Step.11 Cluster heads at i^{th} level take an interest to the $(i+1)^{th}$ level cluster head selection if it is not elected, otherwise just continue cluster heads at i^{th} level [1].

Phase 2: Organization stage

The organization stage begins following the culmination of the election procedure and involves i-specific affiliation sub stages that are completed in a best down manner beginning from the Base Station to straightforward hubs. At this stage, first Ith-level cluster heads relate to the BS, that returns them back the to the time division multiple access (TDMA) table. At that point, the (I− 1)th-level cluster makes a beeline for the closest Ith-level cluster head, that replies by giving the TDMA table; the procedure repeats downwards to the ordinary ad hoc node level
In addition, the accompanying likewise remains constant.
i) Each cluster head controls over few hubs.
ii) Simple hubs finds closest cluster head with separation of single jump.
iii) The transmission scope of straightforward hubs can be diminished regarding the one required by LLC. Therefore, transmission needs less power and the inter cluster obstruction diminishes.
Assurance of the ideal amount of levels for a specified application relies upon the attributes of the sending, the presented hierarchy overhead, the type of hubs, the total degree, the accessible transfer speed and residual vitality.
Routing Methodology:
New underwater co operative routing protocol for under water WSN. Its multi-hop based routing protocol where load on the sensor nodes to send/receive data is reduced significantly by energy balanced routing. In proposed protocol nodes need not required to have information on the entire network to route packets rather only needs neighbor residual energy for decision making for next hop
In proposed architecture nodes are divided into three type as follows.

- Generator Nodes (GN)
- Mediator Nodes (MN)
- Hop Nodes (HN)

Generator Node (GN) is the common sensor node which detects event. Mediator Node (MN) is the node which is available transmission range of GN with lesser hop count. Hop Node (HN) is the node in the range of transmission but lesser hop count of MN from GN.
Process:
Initially GN requests the MN for information regarding HN. Where each sensor nodes stores neighboring nodes
Information such like residual energy through following agents.

- Agent to estimate routing
- Agent to nitor neighbor
- Agent estimate forwarding data
- Agent to estimate depth of node

Assumption : Sink to be on the surface of the water.

By above agents each sensor nodes collects information about HM & which is compared with other nodes data to find suitable HN candidate. Every MN responds to the request with above information to GN. AER (agent to estimate routing) is responsible for Local Table (LT). As sink sends a broadcast packet to each node AER computes hop count from individual nodes to sink stores in local table as a routing database (RD) which stores two table.
LT (local table) which has following information. neighbor node id, hop count, depth, distance, residual energy etc.
RT (routing table) contains previous node, next node, source node& TTL etc.

Algorithm B: Local table establishment

.
//HC_s: sender hop-count; HC_r: receiver hop-count

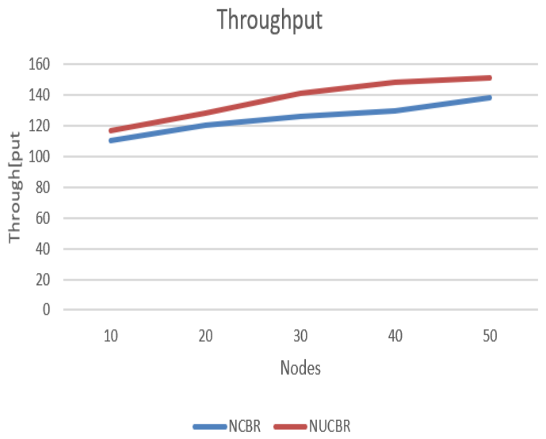
Step1: Sink broadcast packet to all nodes with $HC_s = 0$
Step2: For each node receives packet
While node receives packet
If HCr> HRs+1
Adding sender to LT;
Update receiver hop count $HC_r = HC_s+1$
Broadcast new packet
Else If $HC_r= HC_s$ or$HC_r> HC_s+1$
Add sender to LT;
Discard packet;
End IF
End IF

Algorithm C:Data transfer Mechanism

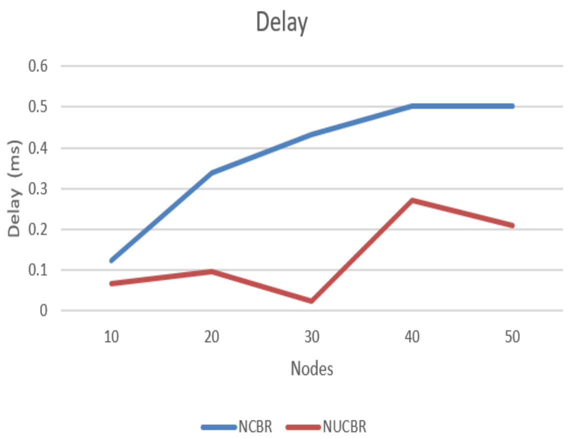
Step1: Generator (sender) node requests (REQ) packet to its neighbors (Mediator nodes)
Step 2: **for** *every mediator node receives REQ packet*
Make a selection from its neighbors hop node
When (hop node. hop count<Mediator. hop count & Hop node.ID any of Sender neighbor.ID & hop node. cost==MIN);
Return REP packet contain(ID, residual energy and cost of hop node)
End for
Step3: **When** *Sender Receives Reply*
• Sender computes overheads to mediator and its hop node and make a selection of best route;
• Sender directs data to mediator node;
• mediator node redirect data to hop node
Step4: **if** *Hop node==sink* **then**
• Stop // Data transfer successful;
else
• Send REQ packet to neighbors (hop nodes);
• hop node return REP Packet;
Repeat Step 3
End if

IV. RESULTS:

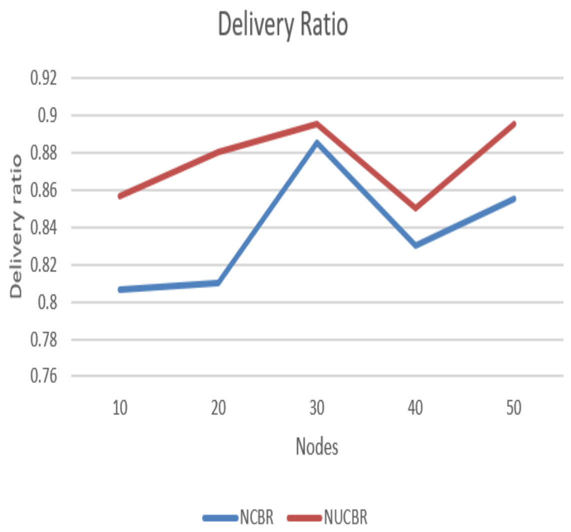
Throughput: This is the quantity of data packets handed from a source node to a target node for every unit of time. The fig.6 shows the throughput attained by various both methods NUSBR & NCBR. The throughput is enhanced and improved in comparison to NCBR. The result visibly displays that throughput attained in our proposed protocol is improved as compared to others. With growing number of nodes the rate of throughput is stable.



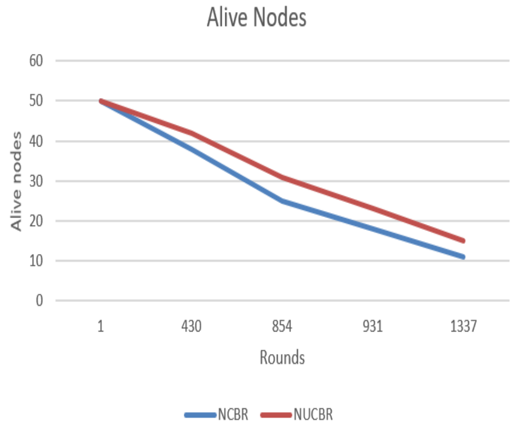
Delay: The variation between accepting time and sending time of packets is considered as delay. The fig.7 shows the delay comparison among protocol NUCBR&NCBR. The transmission delay is highest in NUCBR protocol for 80 nodes. With gradual number of nodes the delay obtained in our protocol is better than others. The delay is marginally expanded with expanding number of nodes 60 onwards in our convention.



Packet Delivery Ratio (PDR): This is the proportion of data on packet received by the destination and data packets sent by the sources. It is clear from Fig.8 that the PDR value achieved by our protocol is acceptable.



Alive Nodes: It can be seen that number of alive nodes increased in NUCBR in comparison to NCBR that defines the energy is been conserved in NUCBR. Fig 9 clearly shows that with the enhancements in scheduling process we are able to improve the network life time 15%



V. CONCLUSION:

In the work done, a protocol that focuses on improving network reliability and effectiveness through cooperative routing and sink mobility is established. For reliable data transmission, cooperative transmission is well known. Based on their depth and residual energy data, prospective relay and target nodes for cooperative routing are chosen in this algorithm. From the results drawn, it can be seen that our proposed algorithm NUCBR works better than the already existing NCBR.

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