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Abstract
Submarine detection is the most significant research area of underwater acoustic (UWA) environment with extensive application in commercial and navy domains. The environmental complexity and variable nature of the UWA makes underwater wireless sensor network (UWSN) to exhibit fluidity, sparse deployment, time unpredictability, frequency selectivity, limited accessible bandwidth, and energy constraints pose problems to underwater positioning technology. These UWA features strive for submarine routing systems that are adaptable, scalable, and highly efficient. Depth-based routing has received lots of interest as it can operate effectively without requiring full-dimensional position information of nodes. However, it has issues of vacant regions and detouring forwards. To delineate the aforementioned problems, this paper proposes an opportunity-based distance vector routing (ODVR) technique. The distance vectors which have lowest hop counts in the direction of sink, for underwater sensor nodes are determined by ODVR via a query method. Then, depending on the distance vectors, a dynamic routing is created to manage packet forwarding. In opportunistic forwarding, ODVR has a minimal signaling cost and minimum energy consumption with the potential to elude void sector and long detours issues. The results of simulations demonstrate that ODVR is outperforming the conventional routing algorithms.

Keywords: Submarine Detection; Underwater Wireless Sensor Network; Dynamic Routing; Energy consumption; End-to-End Delay; packet delivery ratio
1. Introduction

Marine engineering and its related technologies are becoming increasingly important in the human development process in underwater topographic exploration, building of marine engineering and resource development, and nautical scientific analysis. Underwater operations and submarine detection are essential in marine construction projects including artificial island reef building, submarine recovery, laying of underwater pipeline and development of tunnel, and ocean mineral resource research. Currently, submarine detection technology is applied in deep sea engineering and coastal region. However, compared to the conventional satellite navigation and positioning systems, underwater navigation system, particularly positioning and navigation system, are still considerably behind the times. Radio signals are carried over large distance via saline at relatively low frequencies in the complex and changeable deep sea environment [1], [2], and only buoys close to the sea can acquire GPS location signal. As a result, establishing underwater positioning UWSNs has evolved as a potential method for locating the underwater environment. It is used to forecast the ocean and conduct undersea navigation, seismic observation, oilfield exploration, oceanographic surveillance, and underwater navigation, among other things. In these applications, a monitoring and controlling centre is often established to gather data from a large number of sensors that are stationed in underwater to create a UWSN. As a result, data forwarding and routing from sensors towards the sink is essentially a successful method of submarine detection applications [3], which employ a diverse set of underwater methodologies to create a massive data processing for tracking of resource, data gathering, and monitoring. In most cases, center for control and monitor is installed to receive data from UWSN's sensors. As a result, data forwarding and routing from underwater sensors to the sink becomes a critical mechanism for underwater applications. Because of the liquidity feature of the underwater territory, routing in UWSNs is fraught with difficulties [4]–[7]. The underwater wireless communication route suffers from significant signal losses [8] and a complicated multipath effect [9], which results in a higher bit error in communication with restricted bandwidth for underwater audio communication [10]. Furthermore, acoustic channels of underwater have a propagation delay about five orders greater than terrestrial radio channels [11]. The low speed of acoustic signal in water causes communication are subjected to significant Doppler Effect caused by trans-receiver motion or varying surroundings such as surface waves, interior disturbance, and speed variations. As a result, light-weight signaling and flexibility that adapts to the high-quality dynamic link are required for reliable packet delivery via underwater wireless communication. For wireless multihop networks with lossy links, opportunity-based routing algorithms have been proposed to enhance packet delivery ratio and throughput [12]. To reduce packet losses, these protocols take use of the wireless channel and arbitrary routings to achieve contiguous diversity at the receiver [13],[15].

Opportunity routing has been used in UWSNs to combat the high bit error rate in wireless network[16]. On contrast to classical routing mechanisms [17], where sensor nodes rely on predetermined routing table to forward packets, the protocol selects a group of routing options from adjacent sensors to relay data packets to the sink. As a result, data packets have high chance of being transmitted to the sink successfully. There are some opportunity-based routing methods for UWSNs in the literature [18],[20]. The vector-based forward (VBF) mechanism in [21] calculates a "routing pipe" based on each node's position information, and the nodes that are present in this pipe can carry location information of submarine. As a result, the routing pipe towards the destination defines the forwarding path. Obtaining position information, on the other hand, remains a difficult
process in UWSNs. The authors of [22] suggest a depth-based routing (DBR) scheme in which pressure sensors are utilized to determine the depth of submarine. Based on the acquired depth data, DBR eagerly sends location information to shallow nodes, and eventually to the destination on the sea surface. But, in several situations, i.e., a sparsely distributed network, greedy hop-by-hop forward approach may reach a void zone frequently, in which the node is unable to identify an appropriate next hop (bottom node) to transmit its data packets. Both wireless networks and acoustic networks have looked at the empty region in opportunity routing [23]. To recover communication from the void region, [24] proposes a protocol that involves relocating the nodes in void areas to new depth to modify the topology. Traditional opportunity based routing systems need several signaling exchanges across sensor nodes in order to choose the relay candidate set, and to select the forwarders, and coordinated opportunistic forwarding. The forwarding scheme may be implemented easily at each sensor by correlating the depth with the upstream node depth for determining the packet transmission to be carried further, by which DBR protocol decreases signaling overhead. However, in DBR, empty regions are unavoidable. As a result, additional overhead are included to cope with the void region problem, such as location information in VBF and periodical alarms in VAPR. Moreover, it may be necessary to divert packets down another exceedingly lengthy path to avoid the void zone, which is referred to as the long detour issue. The lengthy detour will cause packet transfers to be delayed and squander UWA channels’ limited resources.

An energy efficient distance vector is used in this article to provide opportunistic routing in UWSNs in order to avoid the void area and lengthy detour issues. Each node’s distance vector keeps track of how many hops it takes to get into the sink. An OR based distance-vector (ODVR) mechanism is suggested based on hop-count information to transmit location information of submarine along the possible shortest path.

The rest of this paper is laid out as below. The network model and an overview of ODVR are presented in section II. The design of the ODVR is detailed in Section III. The performance evaluation of ODVR using the results of simulation software is presented in section IV, and in Section V, the paper is concluded.

2. Propagation Model
Sensor nodes of submarine collects position data from their surroundings and send it to the sink node via multi-hop forwarding. A minimum of one surface sink is utilized on the water surface to get location information of submarine from sensors via UWSN channel and transmit them to the base station via wireless radio channel. The transmission begins in the water from the submarine to the destination node.
The expression of energy attenuation in underwater is given by

\[
10 \log \left( \frac{A(l, f)}{A_0} \right) = k \times 10 \log l + l \times \log a(f)
\]  

(1)

Where diffusion loss is expressed as \( k \times 10 \log l \); absorption loss is defined as \( l \times \log a(f) \); normalizing factor \( A_0 \) indicates constant loss; absorption coefficient \( a(f) \); spreading factor \( k \) has a value of 2, 1.5 and 1 for spherical, practical and cylindrical spreading.

The signal is represented as

\[
S_l(f) = SNR (L, f) \frac{N(f)}{A^{-1}(L, f)}
\]  

(2)

Where turbulence noise is expressed as \( N(f) \).

The power of the signal is

\[
P(F) = \int B(l) S_l(f)
\]  

(3)

Where bandwidth is \( B(l) \) with \( l \) coverage radius.

The consumed power [25] is given by

\[-10 \log (\eta P_t(l)) = 170.6 - 10 \log P(l) + DL\]

The energy consumption of packet [26] is

\[
E_p(l) = \frac{(P_r + P_t(l))L}{B}
\]

Where \( \eta, L, B, \) and \( P \) denote constant, length, transmission rate, and the power required to receive location information of submarine.

Comparing with conventional protocols, ODVR has several attracting features. The prominent benefits of ODVR are listed below:

- Avoids “void region” and “long detour” problems: These issues, which are common in depth-based routing, result in a poor packet delivery ratio, a wide delay, and high energy usage. The suggested ODVR protocol makes use of the query scheme in UWSNs to
determine each node's distance vector to the sink. The location information of submarines is sent towards the destination along with the available shortest route based on the distance vectors. The packets do not reach empty zones where nodes have unlimited counts of hop as the distance vector could recognize the void region. At the same time, the shortest-path forwarding strategy of ODVR avoids the lengthy detour.

- **Light-weight signaling with opportunistic routing**: ODVR doesn't require complicated signaling beyond from the query method to determine the distance vector to the sink for underwater nodes. ODVR chooses relay possibilities and coordinates opportunistic forwarding based on the distance vector maintained in each node hop-by-hop node. Unlike conventional OR protocols, ODVR does not require any information about its neighboring sensors and does not require any relay candidate to be included in packet headers. If location information reaches an intermediate node, the receiver makes a decision to reject or resend it, as well as when to do so, based on the distance vector. Further, the source nodes do not require information about the nodes who have received location information successfully and about the candidates who have the ability to forward location information. As a result, ODVR proves to be a light-weight protocol with low signaling overhead and few signaling exchanges.

In multi-hop routing and forwarding, ODVR makes use of distance vectors. Unlike typical routing systems, ODVR does not transmit hop by hop location information along a predetermined path. On the other hand, ODVR takes advantage of any opportunity to relay packets. ODVR uses distance vector to pick possible nodes and organize the packet forwarding as the distance vectors have shown to have high reachability chances to the sink.

The query technique is used by ODVR to create distance vectors for all sensors. In contrast to wireless adhoc networks, the sensor in UWSNs point to a certain sink. Only the sink initiates control messages (inquiry packets) and the distance vectors of the sink are stored by the UWSN nodes. As a result, the overhead in control and buffer storage have been decreased considerably. The distance vector's hop-count is used by ODVR to determine each node's relay priority. The node with the fewest hops to the sink gets the greatest priority in forwarding the location information. As a result, ODVR uses distance vectors in nearby nodes to consider all of the neighboring nodes in the possible hop list. In this case, the information about the relay candidates does not need to be included in the headers of data packets transmitted by sensor sources. The data packets from the sensor sources are simply broadcast to the sink node as their destination.

3. **Design of proposed routing protocol**

ODVR creates distance vectors on a regular basis. The submarine then begins routing through transmission of location information, which is then forwarded to the destination opportunistically by intermediary nodes. The DVOR details are presented in this section.

A. **Establishment of Distance Vector**

To aid in the creation of distance vectors, the query mechanism is used in UWSNs. As the sink is the common endpoint for all sensor nodes in UWSNs, the sink is necessary to start the establishment process of distance vector.

The sink:

The sink creates query packets on a regular basis and broadcasts the location information to the sensors. Figure 2 shows the query packet header. There, the Query ID is a positive integer that starts at 1 and increments by one. As a result, the Query ID of the most recent query
packet is always the biggest. The field n keeps track of the distance from the sink as hop count. At the sink node, the field n is initialized to be zero.

![Query packet header](image)

**Figure 2. Query packet header**

**Underwater nodes:**
Except the sink node, all nodes have a local buffer for recording the sink's distance vector. Unlike conventional distance vector routing, the UWSNs nodes share the same destination. In addition, the forwarding path is not defined in ODVR. Hence, keeping track of the destination and successive hop are not essential. The Query ID and number of hops to the destination in ODVR are recorded in the local buffer using the distance vector. The hop count is initialized to infinity by the node in the buffer. When a query packet is received, the local Query ID and number of hops are refreshed. The algorithm given below describes the steps involved in receiving a query packet.

**Steps involved in receiving a query packets**

**Location Information:**
The query packets are arriving and n hop count;
The QID_i is a local distance vector and N_i (N is initialized to ∞);
initialize
if qID_i > QID_i then
    qID ← QID_i;
    N_i ← n_i + 1;
    The query packet is rebroadcasted by setting n ← N_i;
else if qID_i = QID_i and
    if N_i > n + 1
        N_i ← n_i + 1;
    drop the query packets;
else
    drop the query packets;
stop

The above step is continued till the query packets have been passed to all the nodes. The shortest path towards the sink is established with the fewest hop counts by all the nodes that access the query packet. If new queries do not update the distance vectors, such vectors will be deleted.

**B. Routing and Sending at Sources**
Opportunity based routing picks several possible relay candidates to forward data packet rather than picking a node sequences along a route for forwarding the data. As a result, to aid opportunity based forwarding among possible relays, the sender must choose and send via relay hops with the data packet header, which incur a significant cost for the routing protocol. ODVR does not pick and send relay hops in the data packet header to decrease overhead. Instead of picking relay candidates from the source, ODVR takes use of neighbor node
cooperation to create a distributed relay candidate set. Without any control messages, the source simply delivers the data packets. All data packet contains ID of starting node, sequence number of packet, the preceding forwarder's hop-count \( n_p \), and data payload, as illustrated in figure 3 in which source ID and sequence number of packet are called as global packet ID (GID) as they are used to identify a packet.

![Figure 3: Structure of data packet](image)

When there is no accessible route to reach the destination, the distance vectors prohibit wasteful transmissions. A node in the UWSN may be separated from other nodes due to wave motion, mobility of nodes, or energy depletion in certain nodes. The sink will not send any query packets to this node. This isolated node's distance vector has an unlimited hop-count. Such node should remain quiet so as to avoid transmission power wastage. When it receives another inquiry packet, it starts transmission of data packets.

### C. Opportunistic Forwarding at Intermediate Nodes

Any neighboring node can relay the packets as the sender has not specified the forwarder. But some neighboring nodes do not successfully acquire packets as the variation in link quality reduces signal to noise ratio. The nodes with shorter links have a better chance of receiving data packets successfully, whereas those with longer links merely have a lesser chance. To attain a high delivery ratio, conventional routing schemes take advantage of multi-hop short connections. Despite the low reception probability of lengthy connections, some adjacent nodes may be close to the destination than their neighbors. It appears that taking use of lengthy adjacent nodes, which have poor successful packet reception can speed up data packet delivery they are closer to the sink. The nodes' distance vectors are used by ODVR to enable opportunity based forwarding by long adjacent nodes. The hop count distance and delivery level of data packets from buffered distance vector to the sink can be determined by each node. The problem lies in the un-awareness of nearby node who has successful packet reception about number of surrounding nodes that have the copies of same packet and how far they are from the sink. Network congestion and transmission overlap arise when all nodes are permitted to send their successfully received packets, also increasing UWSN's energy usage and bandwidth. The intermediary sensors must coordinate with one another to prevent repeated forwarding, which further minimizes energy wastage and bandwidth. The problem with coordinated forwarding is that an intermediate node has no idea how many possible relay candidates are nearby or how far apart they are. The relay candidates that have received packets successfully must work together to choose the forwarder who is closest to them. But, a large number of control messages in UWSNs are not desired. The distance vectors created by the query method in figure 6 are dependent on the query packets being successfully received. The query packet can be received straightly from the sink.
by the red nodes (N = 1). The packets are then passed on to the blue (N = 2) and green (N = 3) nodes. Due to the frequent change in UWSN channel, the sink may still be able to receive location information directly from the blue and green nodes. When a green node sends a packet to the sink, it is no longer required for the blue or red nodes to transmit the similar packet.

As a result, the waiting mechanism should serve for two purposes. The first is to provide data packets to the closest nodes a high priority, and then stop sending duplicate packets of the same nodes.

To achieve opportunity based forwarding, ODVR utilizes the following timer setting, i.e.,

\[ t = 2 \cdot [N_i - n_p + 2]^+ \cdot t_0 + \text{rand}(0, CW) \cdot t_{slot}[N_i - n_p + 2]^+ \]  

(1)

where \( \max(-, 0) \) is defined by the operator \([\cdot]^+\), \( t_0 \) is propagation period for optimum coverage range, \( CW \) is the back off windowslow and \( t_{slot} \) is the back off unit time. The \( 2 \cdot [N_i - n_p + 2]^+ \) component takes various numbers of hops in a link into account, while the \( \text{rand}(0, CW) \) part uses arbitrary back off method to avoid information transmission by nodes with the similar hop count. When a node \( i \) gets location information of submarine, the waiting period is estimated by calculating the buffered hops and the number of hops in the demanding node that the packet is delivered by. The node with fewer hop counts spends less time before passing the received packet, as illustrated in (1). When a node \( i \) is one hop close to the upstream node, \( n_p - N_i = 1 \), it waits \( 2t_0 \) plus a brief back off. The roundtrip propagation time between two neighbouring nodes is taken into account by coefficient 2. As a result, during the waiting period, the neighboring nodes can overhear the packet passing and avoid duplicated forwarding. When \( n_p - N_i = 1 \) and \( n_p - N_i = 2 \), node \( i \) requires one \( t_0 \) to overhear node \( j \)'s forwarding. As a result, node \( i \) must wait for \( 2t_0 \) prior to actual forwarding. The redundant forwarding by node \( i \) can be avoided in such situation. There is no waiting period for nodes that have more than two hop count away from the destination.
As the nodes wait for fewer than two hop counts away from the destination, the setting in (1) do not cause considerable delay in packet delivery. The reason for this is that the chances of successful packet delivery after more than two hops are small. As a result, ODVR assigns highest priority to packet forwarding for nodes more than two hops. The below Method summarizes the specifics of the data forward algorithm for the intermediate nodes.

**ODVR protocol based forwarding of data packet**

**Location Information:**
- distance vector of buffered node $N_i$;
- acquired data packet with GID $p_d$ and hop count $n_p$;
- $Q_1$ be the set of GIDs of packets
- $Q_2$ be the set of GIDs of packets.

```
start
if $p_d \in Q_1 \cup Q_2$
    omit the packet $p_d$:
else
    Buffer the packet $p_d$ in $Q_1$;
    Set a waiting timer and set its duration using (1);
end
repeat
if overhearing a packet with GID $k_d$, hop counts $n_d$ & $n_d \leq N_i$ then
    Discard the waiting timer;
Neglect the packet $p_d$;
else
    Transmit the overhead packet $k_d$
end
until The waiting timer is timeout;
if The packet $p_d$ is not overhead then
    Change the hopcount $n_p$ with $N_i$;
    Insert the packet $p_d$ into $Q_1$ for forwarding;
end
end
```

The GIDs of formerly acquired data packets are recorded in two buffers, $Q_1$ and $Q_2$. $Q_1$ assigns for packets that are waiting to be forwarded, whereas the buffer $Q_1$ is assigned for packets that have already been forwarded. To avoid repeated forwarding, the incoming packet should be dropped once it has received in $Q_1$ and $Q_1$. Or, the node will begin a waiting timer with a duration determined by the user (1). The node will change the packet header’s hop-count $n_p$ with its own hop-count $N_i$ when the timer has expired, then sent the packet. The node continues to receive packets throughout the waiting time. It will reject a packet if similar packets are sent by a closer node to avoid redundancy.

According to the ODVR algorithm, a packet telecasted by a node with a hopcount $N_i$ can be observed by several intermediary nodes with a hop count smaller than $N_i$. The waiting scheme, on the other hand, gives the higher priority to the node with the fewest hops by waiting for shortest period. ODVR does not allow nodes with the similar hop count to transmit packet consecutively in a flooding manner.
The media access control for shared-channel UWSNs will prevent several nodes from using the channel simultaneously. When one node is connected to the channel and transmits a packet, the surrounding nodes may hear it and cease forwarding the same copy. Furthermore, by delaying data forwarding in various nodes at random, the random back off avoids causing severe conflict in the media access control.

It's worth noting that the ODVR protocol may easily be extended for numerous sinks applications. The query packets must be sent by several sinks. The underwater sensors must keep track of how many hops it takes to reach any of the sinks. When a packet reaches an intermediary node, it is handled in the similar fashion as when it arrives at a single sink.

4. RESULTS AND DISCUSSION

The proposed ODVR protocol is implemented in NS2 simulator to evaluate its performance by comparing with APCR and DEEP in. Around 200-400 nodes are deployed arbitrarily in a space of 1000m * 1000m *1000m.

**Simulation Parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Transmission model</td>
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<tr>
<td>Underwater channel model</td>
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<tr>
<td>Energy Consumption</td>
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<tr>
<td>Signal to noise ratio model</td>
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<td>Sound speed underwater</td>
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<tr>
<td>Transmitted Power</td>
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<tr>
<td>Received power</td>
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<tr>
<td>Transmit power</td>
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<td>Size of Packet</td>
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<tr>
<td>Size of packet header</td>
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<td>Initial energy of each node</td>
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<tr>
<td>Initial energy of sink node</td>
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<td>Data transmission rate</td>
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<td>Number of nodes</td>
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<tr>
<td>Number of sinks</td>
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</table>

The total energy consumption, average end-to-end latency, average hop-count of delivered packets, packet delivery ratio (PDR) and network lifetime are chosen to measure the submarine detection performance in the UWSN.
The relation among overall energy used and number of nodes is seen in figure 5. As the number of nodes grows, so does the overall amount of energy consumed. The total consumed energy of APCRP (Adaptive Power controlled Routing Protocol) is more than DEEP (distributed energy efficient and balanced routing algorithm) and ODVR. When APCRP is unable to locate a relay node before transmitting data packets, the energy consumption will get increased for setting up node power levels to a high level. The packet collisions cause the cross layer node to be identified as a relay node, by which APCRP increases total energy usage. APCRP and DEEP consume significantly more energy than ODVR. Because in APCRP and DEEP, sensor nodes transmit probe packets to identify relay nodes before transmitting data packets, which increases energy consumption. ODVR, on the other hand, uses directional forwarding to choose the optimal relay node so as to minimize flooding and save energy. Furthermore, ODVR prevents cyclic transmission to save overall energy.
The relation among average end-to-end latency and the number of nodes are shown in figure 6. It is observed that APCRP and DEEP have a greater average end-to-end latency than ODVR. The delay of nodes is substantially decreased in ODVR because nodes deliver data packet instantly to the trustworthy node. Furthermore, to minimize the latency, ODVR eliminates cyclic transmission. When DEEP or APCRP find difficult to locate the proper relay node prior to delivering data packets, ODVR will repeatedly transmit probe packets until it locates the proper relay node, resulting in a significant rise in the latency of nodes. DEEP has a longer average end-to-end latency than APCRP because DEEP transmits probe packets continuously until it finds an acceptable relay node, whereas APCRP picks a relay node by changing power levels of sensor nodes to reduce latency.
For different nodes quantity, the average hop-count of dispatched packet is shown in figure 7. As shown, ODVR has the lowest average hop-count than APCR and DEEP. In APCR, the forwarder is chosen based on sensor node depth information, without considering the datum from the destination. The packets are transmitted more quickly to the shallower nodes. The lengthy detour problem occurs with APCR as the shallow nodes may be too far from destination node. In ODVR, nodes that are close to the destination (in hop-count) are more likely to send the location information with greater priority. As a result, ODVR frequently sends packets along the shortest route, with the fewest hops.
The packet delivery ratio of APCRP, DEEP, and ODVR are compared in the figure. It indicates that ODVR outperforms DEEP and APCRP in terms of delivery ratio, with APCRP showing the least performance comparatively. Sensor nodes in APCRP simply forward data packets from deep to shallow. If a packet reaches a node that has no accessibility and a shallow neighbor, it reaches a void area that can lead to packet loss. The horizontal distance, on the other hand, was not taken into account in APCRP. Even if the packets are sent to nodes at the water’s edge, they may get lost if the sink node is out of coverage area. As a result, the APCRP delivery ratio is limited, particularly if the number of destination nodes is low. As the location information is directly transmitted to the sink nodes, the delivery ratio is very high in ODVR, and the nodes that are close to the sink are given more priority. The sensor node’s forwarding priority is related to its depth in DEEP, hence sensor nodes closer to destination (hop-count) may get fewer priority than that are far away. As a result, DEEP has a lower delivery ratio than ODVR.
The relation between network lifetime and simulation running time is shown in Figure 9. The network lifespan of sensor nodes begins to dwindle as the simulation progresses. The network degradation rate of sensor nodes in APCRP is quicker than DEEP and ODVR when the simulation time is below 500s because sensor nodes in APCRP has not identified relay nodes prior to transmitting data packets; hence, more power is utilized till the best relay node is identified. Further, the cross layer node may be treated as relay node in APCRP due to packet collision. The aforementioned factors cause certain nodes to use excess energy, resulting in a wide gap between their residual energy and the network's average residual energy, causing some nodes' energy to be quickly depleted, resulting in an increase in the mortality rate of sensor nodes. DEEP's network lifetime degradation rate is below 20% at the end of the 900s, whereas ODVR's network lifespan was higher than APCRP and DEEP's because ODVR considers the sensor nodes' residual energy to prevent cyclic transmission, such that the energy is distributed to balance the network lifetime. As the time passes from the 900s to the 1000s, the ODVR network's lifetime decays exponentially from 10% to 1. In ODVR, as the residual energy of each node falls below the minimal energy, the network is paralyzed at the end of its lifetime. Finally, it was shown that the ODVR's energy distribution are balanced more than DEEP and APCRP.

Conclusion
A novel routing algorithm called ODVR is proposed in this paper for UWSNs to detect submarine. ODVR used query method based distance vectors to enable forward routing without complicated signaling to identify submarine and coordinate packet forwarding among possible relays. ODVR assures that the topology is legitimate and can be applied to an environment with dynamic network. The identification of each node has been taken into
account to characterize sensor nodes' transmission capacity so as to avoid communication void regions and long detours during forwarding of location information and to provide energy efficient routing. Thus the performance of proposed routing protocol is proved to be superior to existing DEEP and APCRP methods in terms of total consumption of energy, PDR, average hop-count of data packets, average end-to-end delay, and network lifetime.

Declaration:

Ethics Approval and Consent to Participate:

No participation of humans takes place in this implementation process

Human and Animal Rights:

No violation of Human and Animal Rights is involved.

Funding:

No funding is involved in this work.

Conflict of Interest:

Conflict of Interest is not applicable in this work.

Authorship contributions:

There is no authorship contribution

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References


