



# Reduction of Data Transmission Time Delay with Object Detection in Underwater Acoustic Sensor Network

M. Pragathi<sup>1</sup>, R. Kumar<sup>2</sup>

<sup>1</sup>Embedded System Technology, <sup>2</sup>Electronic and Communication Engineering

<sup>1,2</sup>SRM Institute of Science and Technology, Kattankulathur, Chennai, India

\*Corresponding Author Email: [praga730@gmail.com](mailto:praga730@gmail.com)

## Abstract

Underwater acoustic sensor networks play a vital role in many applications such as monitoring underwater environment, location and object detection etc.,. In environment monitoring, the sensor nodes monitor the unwanted obstacles and transmit the information about the obstacles to Base Station (BS). The major problem is when sending data from two or more number of sensor nodes at the same time the time delay in data transmission will be increased. In this project, to overcome the problem of end-to-end delay, mobile data collector is employed with waterproof ultrasonic sensor nodes in underwater acoustic sensor network.

**Keywords:** Arduino UNO, Node MCU, Zigbee transceiver, water proof ultrasonic sensor; Arduino software; Iot based cloud network.

## 1. Introduction

Underwater acoustic communication is a technique used to send and receive data from underwater environment. When data are sent through underwater communication part is very difficult when compared with terrestrial communication. Due to the some properties in underwater environments and acoustic communications, underwater acoustic sensor network consumes more energy when transmission occurs through underwater condition. The transmitting power is based on the distance between the communication nodes and the amount of information that is transmitted between them. The receiving power is based on number of data bits it receives. As a result, if the power consumption can be reduced, the lifetime of the network can be increased. By locating the sensor node in shorter distance the lifetime of the sensor network will be increased. For transmitting data the initial positions of the sensor nodes Sensor Node (SN) are determined when the transmission occurs. The distance between some SNs may be too long so that the communication between them will be lost and power consumption will be high, it results in lack of network lifetime in sensor network. To increase the network lifetime, Relay nodes (RN) have to be added to the network to reduce the distance between SNs and base station, this process results in increasing network life timing.

Acoustic Sensor Networks (UW-ASN) has a several number of sensors nodes that sense over a long area of sensor network which can adjust to the qualities of the sea condition. Acoustic correspondences are the normal physical layer innovation in underwater systems. The radio waves engender in ocean water at long distance in low frequencies (30-300 Hz), for high transmission the sensor network requires apparatus like high frequency sensor nodes.

The approach of sea base observing is to convey that submerged sensors record information from underwater and afterward recoup the instruments. The protest identifying sensors like ultrasonic

different applications, for example, water profundity estimation, question location and so forth., ultrasound utilizes the high-recurrence sound waves for both transmission and getting odd information's from submerged condition. At the point when a protest is identified in a specific bearing the ultrasonic heartbeat, if there is a question in the way of this heartbeat the beat will be reflected back to the transmitter as a reverberate and the resound stick can distinguish those heartbeat through the collector way. By estimating the distinction in time between the beat which is transmitted and gotten, it is conceivable to decide separation of the specific question. The ultrasonic signs are utilized for question location by delivering a burst and distinguishes its appearance after the flag hits the protest. The recurrence run for ultrasonic signs is in the scope of 40 kHz. To gauge the profundity, plot for reflected ultrasonic signs is ascertained. Ultrasonic signs have great directionality and they are effectively reflected by strong articles.

## 2. Proposed System

For prolonging the network lifetime issue in underwater acoustic sensor network heuristic scheme for UASNs is used. Acoustic sensor network is more useful than the normal wireless sensor network because of the battery equipped sensor nodes. In underwater environment recharging battery of sensor node is very difficult. In this work, flow allocation of a sensor node and relay node placement is considered as a problem. Integer nonlinear programming problem is formulated to solve this problem. For solving this issue a novel heuristic scheme for underwater acoustic sensor network is used. It is represented in 3-D view of Underwater Acoustic Sensor Network. In the 3D view of UASN architecture, the water body is designed in cylinder shape and the radius of the water body is denoted  $W$  and depth as  $D$ . The underwater sensor network have several number of sensor nodes which is denote as SN which is used to collect data from underwater circumstance.

sensors convey high recurrence ultrasonic sounds that ultrasound which is utilized as a part of numerous courses, for

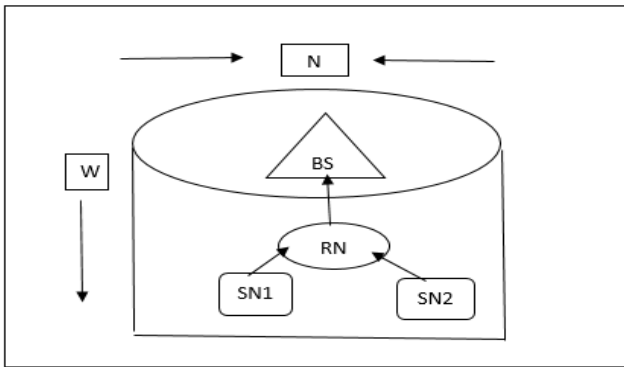


Fig. 1: Relay node placement and Flow allocation

The figure.1 represents the relay node placement and how the data is transmitted through the sensor node’s to base station (BS). UASN has several sensor nodes and relay nodes, whereas Sensor node (SN), Relay node (RN) and Base station (BS) is placed under cylindrical water tub with depth of ‘W’ and length of ‘N’ and is placed in the center of the water body. The relay node is placed in between the two sensor nodes, it act as an intermediate node which is used to transmit data from sensor node to base station. While transmitting the data transmission time delay occurs when number of nodes increased in sensor network. For reducing the time delay mobile data collector is employed with sensor network. Algorithm 1 and Algorithm 2 is designed for measuring distance of object from underwater using ultrasonic sensor and also for implementation of mobile data collector in underwater sensor network.

**Algorithm 1** Measuring distance in ultrasonic sensor

- Step 1:** Set Arduino pin tied to Echo pin and trigger pin on the ultrasonic sensor.
- Step 2:** Defining maximum distance to ping for (in centimeters).
- Step 3:** Set up the Open serial monitor at 9600 baud to see ping results.
- Step 4:** Set time delay wait for 10us between pings (about 20 pings/sec). 29ms should be the shortest delay between pings.
- Step 5:** Get ping time in microseconds (us).  
`unsigned int o,uS = ultrasonic.ping();`
- Step 6:** Convert ping time to distance in cm and print result.  
`Serial.print( o / US_ROUNDTRIP_CM);`
- Step 7:** Run the code.

**Algorithm 2** Mobile data collector

- Step 1:** Create API key connect with wifi connection.
- Step 2:** Receive data from sensor node.
- Step 3:** Read the data from sensor node  
`String inchar = Serial.readStringUntil('\n');`  
`a = inchar.substring(7);`
- Step 4:** Sending Data to Thingspeak Channel  
`client.print("X-THINGSPEAKAPIKEY: " + TS_API_KEY + "\n");`
- Step 5:** Run the code and displays the distance in waveform.

**3. Design and Implementation**

In underwater environment, UASN is useful to detect many unwanted obstacles which is present in under water environment.

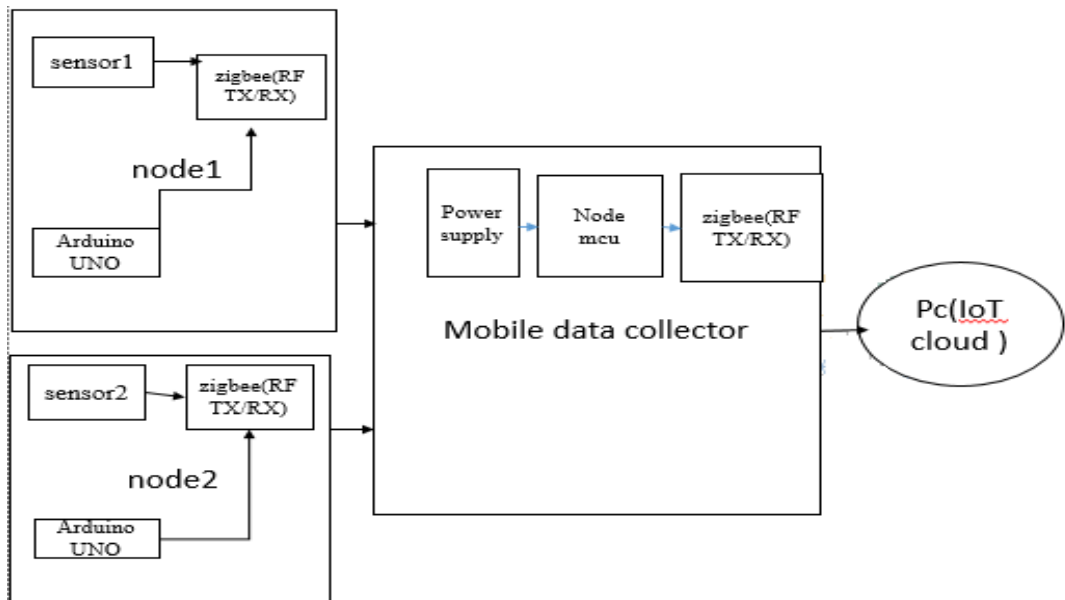


Fig. 2: Block diagram of employing mobile data collector in underwater acoustic sensor network

Underwater ultrasonic sensor is self-configured sensor and it can transmits information such as distance and location to base station (IoT cloud network). While transmitting data from sensor node to base station the time delay will be increased when the sensor network collects data from more than one sensor, for reducing the average time delay in sensor network mobile data collector is implemented in underwater acoustic sensor network. Figure.2 represents the feasibility of employing mobile data collector in underwater acoustic sensor network. Each sensor node contains underwater ultrasonic sensor with Arduino Uno controller and Zigbee transceiver. Data from each sensor node transmit to mobile data collector. Here, the mobile data collector collects the data by node MCU controller and transmits to base station through Zigbee transceiver in IoT cloud network.

**A. Surface level testing in mobile data collector**

For testing the mobile data collector in surface level the sensor nodes and mobile data collector is connected with power supply. Both sensor are placed in particular distance. Each sensor node contains one ultrasonic sensor node, Arduino UNO and Zigbee transceiver. Whereas the mobile data collector contains node MCU and Zigbee transceiver



Fig. 3: Surface level testing in mobile data collector

Figure. 3 represents the surface level testing in mobile data collector. The data are measured through the transducer which is connected with waterproof ultrasonic sensor and the measured values are analyzed and send through zigbee (HC-12) transceiver. The transducer can measure the distance by sending high frequency sound pulse, the high frequency sound pulse hit the particular obstacles and return back to the transducer itself, the transmitted data are collected by a mobile data collector by zigbee transceiver and send to base station in cloud network.

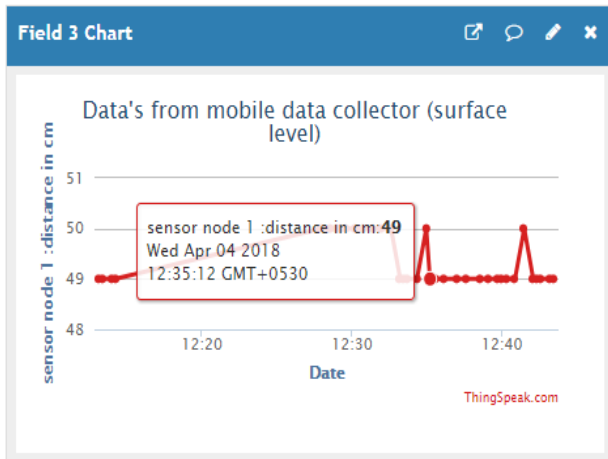


Fig. 4: Distance measurement in sensor node 1

Figure.4 represents that data from mobile data collector is viewed through IoT cloud network, the distance (49cm) of object and time of data transmission of sensor node1 is viewed in this IoT network.

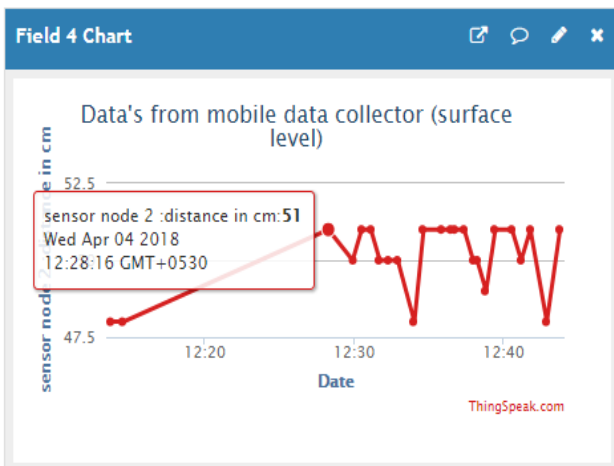


Fig. 5: Distance measurement in sensor node 2

Figure.5 represents that data from mobile data collector is viewed through IoT cloud network, the distance (51cm) of object and time of data transmission of sensor node1 is viewed in this IoT network.

In surface level measuring, the obstacle is placed in the particular distance, the high frequency pulses is generated by the transducer. Practically, the distance of the obstacle can be measured by measure the distance between the transducer and the obstacle. The data are send in Iot based cloud network and the values are simulated in a particular channels .The measured values are tabulated with time delays when the data are received in the base station is shown in table 1.

**B. Underwater testing in mobile data collector**

In under water testing obstacles are placed in water tub with some particular distance, node 1 transducer is placed in left side of water tub and node 2 transducer is placed in right side of the water tub.the two sensors can measure the data from different location when 2 obstacle are detected,both sensor nodes send different data values. the values are tabulated in Iot cloud network in simulated wave form.the figure represents the object decting operation occurs in the under water environment.



Fig. 6: Underwater testing in mobile data collector

The figure.6 represents underwater testing in mobile data collector. Both transducer from sensor node 1 and sensor node 2 is submerged into the water surface. For each sensor one obstacle is placed in opposite direction in particular distance. The high frequency sound signal from the transducer hits an object and return back to the transducer itself. By knowing how long the signal transmitted and received, the distance of the object will be measured respectively.

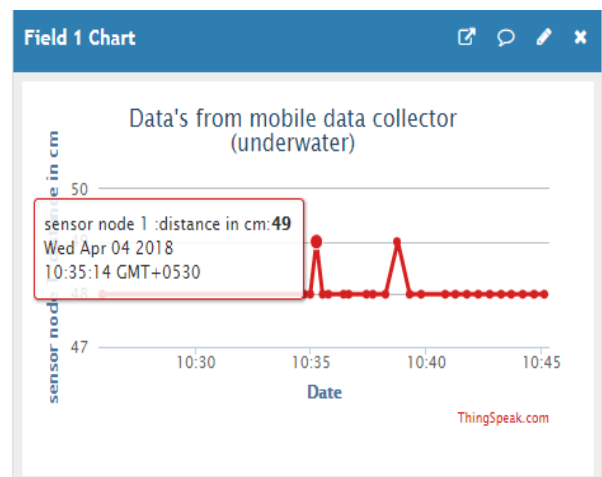


Fig. 7: Distance measurement in sensor node 1

Figure.7 represents the object distance measurement in under water. The data from mobile data collector is received by base station (in IoT cloud network) and displays about distance and time of the object which is present inside the water. The figure.9 shows the time and distance (49cm) of the object in sensor node 1.

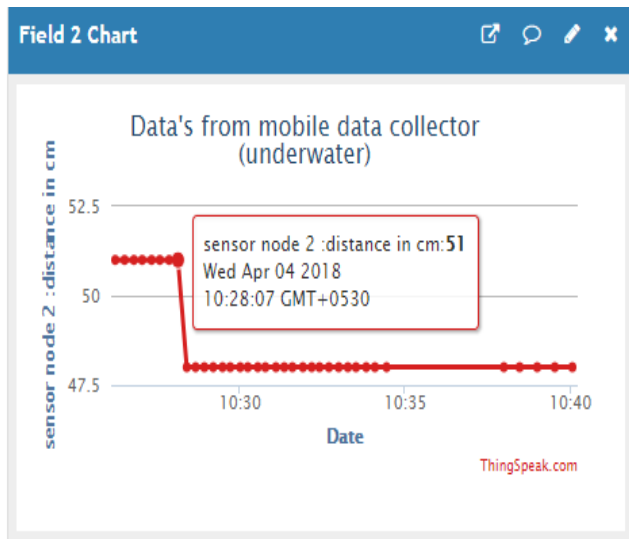


Fig. 8: Distance measurement in sensor node 2

Table 1: Surface level and underwater testing in mobile data collector

s. No	Surface level testing in mobile data collector(distance in cm)		Time delay in surface level(for both node 1 and node 2 in micro sec)	Underwater testing in mobile data collector (distance in cm)		Time delay in under water(for both node 1 and node 2 in micro sec)
	Node 1	Node 2		Node 1	Node 2	
1	48	48	10	50	50	12
2	49	49	16	49	49	16
3	50	50	11	51	51	15

### 5. Conclusion

In underwater acoustic sensor network, the data transmission will more complex and difficult to transmit a data through underwater circumstance. While data transmission the time delay is increased when the several number of nodes transmit the same data to one base station from a long distance. In this paper, to overcome the problem of end to end delay, mobile data collector is employed with ultrasonic sensor nodes in underwater acoustic sensor network. Mobile data collector the data from different location with minimum delay.

### References

- [1] G. A. D Caro and E. F. Flushing, "Optimal relay node placement for throughput enhancement in wireless sensor network.,"in Proc. 50<sup>th</sup> Fed Telcommun. Eng. Eru. Commun.Conr, palermo, Italy, Aug 2011.
- [2] R. Su, R. Venkatesan and C.Li, "Autonomous depth adjustment for underwater sensor network:Design and Application, "IEEE/ASME Trans. Mechatronics, vol.17, no. 1,pp. 16-24, Dec. 2012.
- [3] H. Yan et al, "DSP based receiver implementation for OFDM acoustic moderns, "J. Phys. Comm. Vol. 5, no.1, pp.22-32,Mar 2012.
- [4] K. Lu, G. Lui, R. Mao and Y. Feng, "Relay node placement based on balacin power consumption in wireless sensor network, "IET Wireless sensor Syst, vol. 1, no.1, pp.1-6, Mar 2011.
- [5] M. Stojanovic, " On thr relation between capacity and distince in an underwater acoustic channel, "ACM Sigmoblie comput. Commun Rrv., vol.11, no.4, pp.41-47, Jun. 2006.
- [6] K. Suganthi and B. V. Sundaram, " A constraint based relay node deployment in heterogeneous wireless sensor network for lifetime

Figure.8 shows the data like time and distance (51cm) of the object in sensor node. While analyzing the data from both sensor node the time delay for data transmission is reduced.

### 4. Result Analysis

In underwater acoustic sensor network, the mobile data collector collects the data from each sensor node from different loction and send through cloud network. The data from the mobile data collector is simulated in the field sensor node 1 and sensor node 2 in IoT cloud network. The measured values from both the sensor node is tabulated. When compared with surface level measurement and underwater measurement the delay is reduced and the communication is improved.

From table 1, both surface level and underwater testing in mobile data collector is analyzed, it represents the distance of the object and how much time delay occurs in both the nodes.

In under water testing node 1 and node 2 transmitted the data like distance of object which 50 cm in same time delay of 12 micro seconds. In surface level testing node 1 and node 2 transmitted the data like distance of object which is 49cm in same time delay of 10 micro seconds. While analyzing these results the delay is reduced in data transmission when number of sensor node is increased.

maximization" in Proc. 4<sup>th</sup> Int. Conf. Adv. Comput.(ICoAC), Chennai, India, Jul. 2012, pp.1-6.

- [7] J. H. Chan and L. Tassiulas, "Routing for maximum system lifetime in wireless ad-hoc networks, "in Proc. 47<sup>th</sup> Allerton Conf. Commun. Control. Comput.,Monticello, Va, USA, Sep.2010,pp. 90-91.
- [8] A. Michail and A. Ephremides, "Energy efficient routing for connection oriented traffic in ad-hoc wireless network, " in Proc. 11<sup>th</sup> IEEE Int. Symp. Pers., Indoor, Mobile Radio Commun., vol.2. London, U.k., Sep. 2000, pp. 762-766.
- [9] Y. t. Hou, Y. Shi, H. D. Sherali, and S. F. Midkiff, "On energy provisionnng and relay node placement for wireless sensor network,"IEEE Trans. Wireless Commun., vol., 4, no.5, pp. 2579-2590, Sep. 2005.
- [10] W. H. Thorp, "Analytic description of the low frequency attenuation coefficient, "J. Acoust. Soc. Amer., vol. 42, no. 1, p.270, 1967.
- [11] S.V.Manikanthan and T.Padmapriya "Recent Trends In M2m Communications In 4g Networks And Evolution Towards 5g", International Journal of Pure and Applied Mathematics, ISSN NO:1314-3395, Vol-115, Issue -8, Sep 2017.
- [12] S.V. Manikanthan , T. Padmapriya "An enhanced distributed evolved node-b architecture in 5G tele-communications network" International Journal of Engineering & Technology (UAE), Vol 7 Issues No (2.8) (2018) 248-254.March2018.
- [13] S.V. Manikanthan, T. Padmapriya, Relay Based Architecture For Energy Perceptive For Mobile Adhoc Networks, Advances and Applications in Mathematical Sciences, Volume 17, Issue 1, November 2017, Pages 165-179