Underwater Wireless Sensor Network Data Collection Using Autonomous Underwater Vehicle and Internet of Things

Dinesh Kumar Karri, Fatemeh Gholizadeh, Jean Claude Santiuste, Electrical and Computer Engineering, George Mason University, Fairfax.

Project Proposal

Over 71% of the earth's surface area is covered with water. These water bodies trigger climatic and temperature changes across the globe [1]. Gathering behavioral data within bodies of water can be helpful to detect environmental changes in advance and reduce its effect on the world. Internet of Underwater Things (IoUT) is a class of IoT, which has four main applications, including environmental monitoring, underwater exploration, disaster prevention, and military. In IoUT, a Wireless Sensor Network (WSN) is established underwater, which can collect vital data. Since long-range Radio Frequency (RF) communication is not possible in aquatic environments, acoustic communication, which is an expensive alternative has been adapted [1-2]

Traditional Approach

As illustrated in Figure 1, in order to get data from underwater WSN, there is a sink or an intermediate transceiver which can take the data from the sensor and send it to the sink. As the sink obtains data from the sensor or the transceiver module, communication with the gateway is initiated. Ultrasonic long-range communication techniques are used which are expensive [1].

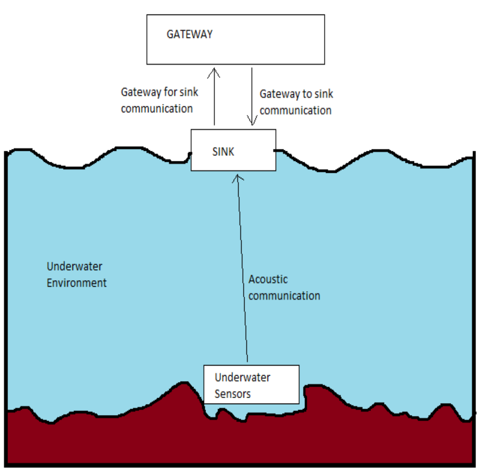

Fig.1. Getting Data Using Acoustic Communication

Proposed Approach

Our project is to introduce an underwater robot as a data transceiver for the underwater WSN. Due to changes in underwater environments occurring gradually, samples of data can be collected at a specific interval of time. The robot will dive in close to the sensors, which will decrease the data transmission range. The minimal distance between the sensor and the robot will allow for the application of communication methodologies that are less expensive than acoustic communication (Eg: RF). Lastly, the robot will travel to the surface and transmit data to the gateway through traditional wireless transmission methods used in IoT. Successful implementation of this idea could potentially decrease the cost construction of WSNs. The proposed method is illustrated in Figure 2.

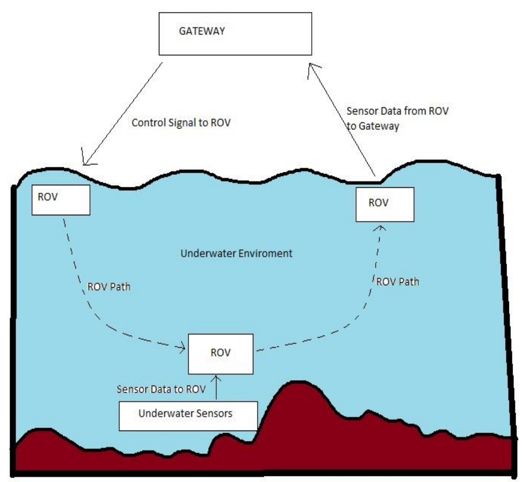

Fig. 2. Proposed Method of Getting Data

Relevance to IoT

In a broad definition, IoT is a network of heterogeneous, networked embedded devices and objects with the ability to communicate without human interference [3]. IoUT also is defined as "the network of smart interconnected underwater objects" and has the same function and structure of IoT [1]. Our proposed project is a smart system that can collect data and transmit the data wirelessly to a gateway or a server from which the monitoring can be done remotely. As a result, this is an IoT problem that can be narrowed down to underwater applications.

Technical Approach

The underwater glider is the robotic platform used to collect data from sensors in our proposed project. Below in figure 3 is the 3D CAD model developed on AutoCAD Inventor Professional 2019. The glider is made from a bottle with additional custom designed parts. These parts are manufactured using 3D printing techniques. This glider works on the principle of change in buoyancy where a 60 ml syringe is used to alter it**.**

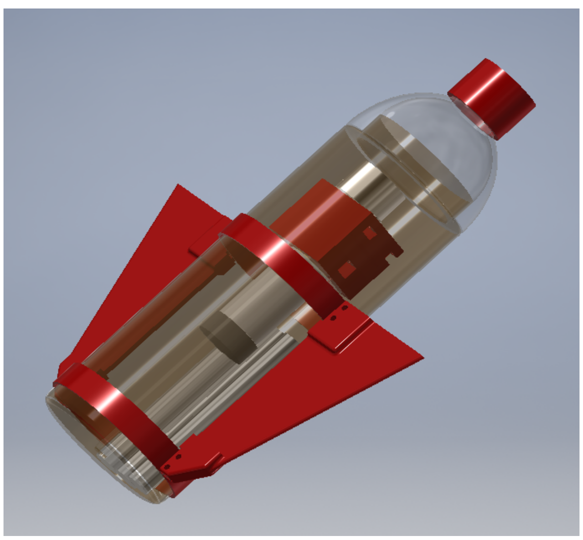

Fig.3. 3D CAD model of the Underwater Glider

Circuit diagrams of underwater glider and sensors are illustrated in Figure 3 and 4.

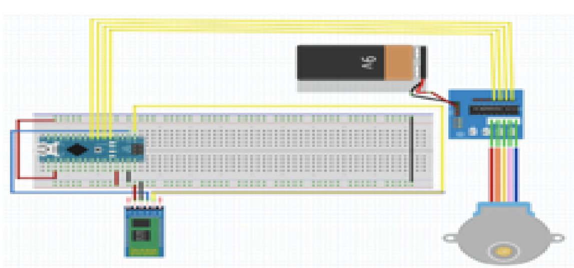

Fig.4. Diagram of the Underwater Glider

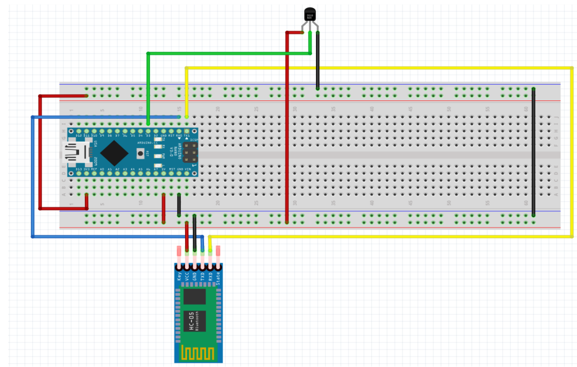

Fig. 5. Diagram of the Underwater Sensors

Project Cost and Bill of Materials

The proposed project requires eleven main components. The list of required components and their associated costs is shown in Table 1. The estimated total cost of the project is $95.49.

Serial No.	Item	Cost in USD	Link
1	Waterproof DS18B20 Digital Temperature Sensor + Extras	9.95	Temperature sensor
2	Arduino Nano x3	13.86	Nano
3	HC-05 Bluetooth module x3	8.75	HC-05
4	Pressure Sensor	5.95	Pressure sensor
5	Stepper motor		Form the kit
6	Syringe Catheter		Available with us
7	Arduino Power Management board	9.99	Power Board
8	Android Smart Device		Available with us
9	Stepper Motor Driver Board	6.99	Stepper Motor Driver
10	3D print parts	20	3D print filament

11	Misc.	50	Multiple products

Table 1: List of Components and Their Costs

Risk and Alternative Approach

There are two potential points of failure for our project. One is where the robot (Underwater Glider) does not achieve an appropriate buoyancy (positive/negative) or the propagation of RF communication signals for near field communication cannot be achieved. If any of the above occurs, we have an alternate solution. The alternative approach is to use multiple Arduinos that will act as data transmission nodes. The sensor on the water tank floor communicates with the closest Arduino. This Arduino sends data into the next node and then to the sink which sends data to the gateway.

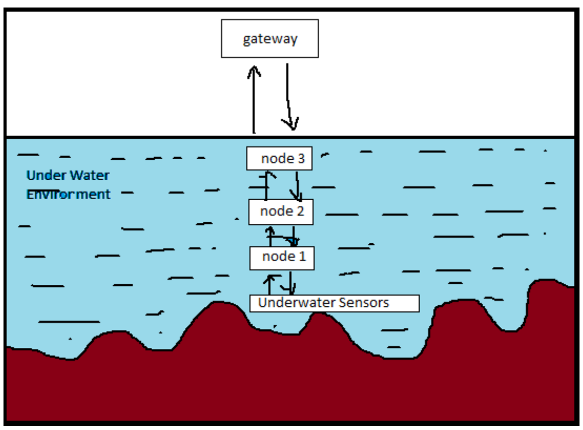

Fig.6. Diagram for alternative approach

Time Required: 5 to 6 weeks

REFERENCES

[1] E. Liou, C. Kao, C. Chang, Y. Lin and C. Huang, "Internet of underwater things: Challenges and routing protocols," *2018 IEEE International Conference on Applied System Invention (ICASI)*, Chiba, 2018, pp. 1171-1174.

[2] Mari Carmen Domingo, An overview of the internet of underwater things, Journal of Network and Computer Applications, Volume 35, Issue 6, 2012, Pages 1879-1890, ISSN 1084-8045.

[3] F. Samie, L. Bauer and J. Henkel, "IoT technologies for embedded computing: A survey," 2016 Int. Conf. on Hardware/Software Codesign and System Synthesis (CODES+ISSS), 2016, pp. 1-10. [online].