International Journal of Advanced Culture Technology Vol.8 No.3 269-274 (2020)
DOI https://doi.org/10.17703/IJACT.2020.8.3.269

IJACT 20-9-34

Wireless network design for construction of atmospheric and marine environment monitoring system using buoy

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Abstract

It has used buoy for efficient domestic farm operations and fishermen fish. Buoy uses IoT-based communication to transmit water temperature, salinity, humidity, wind speed, etc. to fishers in real time.

In this paper, we utilize LoRa, which enables communication in the marine environment, to construct a network and apply it to an actual buoy for monitoring.

The implemented LoRa uses the 900MHz band to configure the network. The sensor consisted of a sensor that can monitor the atmospheric environment and a sensor that can monitor the marine environment. In addition, the information received in real time will be provided to the fishing village host. The fishermen were fully aware of this and took appropriate measures to conduct sea trials.

Keywords: *LPWAN-LoRa Network, Wireless IoT Communication, buoy, marine environment*

1. Introduction

In modern society, not only the connection of computers, but the Internet of things (IoT; internet of things) technology that connects things with the Internet is drawing attention [1-4]. Internet of Things devices are currently being developed and provided with a number of affordable and easy-to-use hardware and software based open source platforms.

In particular, Technology that collects information using various sensors that observe external conditions and transfers data directly to the Internet of Things, cloud servers, and smart devices is being actively researched [5-7]. We are working to improve the safety and work efficiency of fisheries, transportation, passenger services, etc. by combining IoT at sea and ocean.

In particular, Research is underway to integrate the IoT technology to minimize damage to fishermen in the 2016 Ministry of Marine Affairs and Fisheries [8]. In order to reduce the damage to fishermen, there is a need for technology that can efficiently transfer information to the central control center in real time using an IoT-based network [9, 10]. To implement the buoy monitoring and central control technology system, automation such as buoy management, remote monitoring on farms and land and central monitoring technology will be carried out. The technology installed on the phrase and displayed on the GPS plotter of the fishing boat by receiving the position information from the electronic part from now on has been commercialized.

However, there is a lack of research on monitoring technology that comprehensively provides buoy status information and fishing ground information through automatic identification buoys, comprehensive support

Manuscript Received:August 05, 2020 / Revised:August 29, 2020 / Accepted: September 08, 2020
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monitoring technology for fishermen, and onshore control center operation technology.

Therefore, this paper describes multiple buoys and gateways. Buoy collects atmospheric and marine environmental information, and describes the experimental results of hardware and software design and manufacturing based on LoRa for fishermen to monitor. Provide a system that monitors the sent air environment information and marine environment information and provides them to fishing village contracts.

2. LPWAN-LoRa -based Wireless Network

Fig. 1 shows a scenario that utilizes buoy's framework to be implemented in this research. Buoy, which waits at regular intervals and uploads ocean information to the gateway, and communicates with these buoys in real time to many. It consists of a gateway that manages all buoys, and thus a central surveillance system that controls the central control.

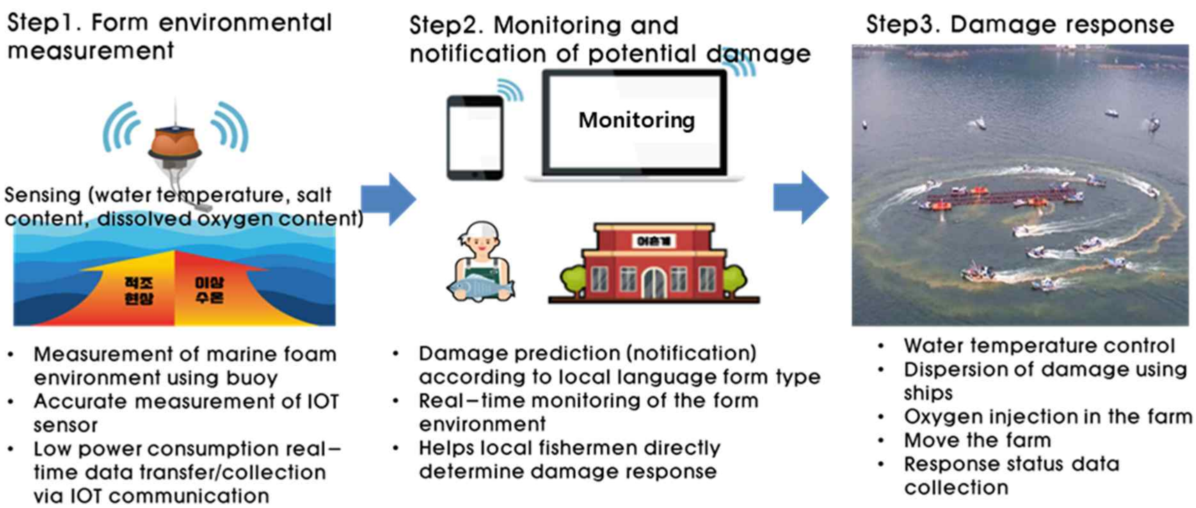

Fig. 1 scenario that utilizes buoy's framework

Install LPWAN-LoRa -based gateway to provide buoy and marine network services located within a 10 km radius.

Buoy uses LPWAN-LoRa-based communication to communicate with the gateway. The information sent is information obtained from atmospheric and marine environment sensors. And it is GPS reception information that can confirm the position of the buoy. The environment of the form such as received water temperature, salinity, dissolved oxygen content, etc. is acquired by the fishing village contract, monitored and responded in case of emergency to minimize the possibility of damage.

2.1. Proposed buoy Composition

SEMTECH's SX1276 LPWAN-LoRa was selected as the network for atmospheric and marine environment monitoring. A frequency band channel allocation method is considered when designing LPWAN-LoRa communication. The frequency band that the SX1276 can use is from 137hz to 1,020MHz, and the bandwidth is 125kHz. First, a frequency band for frequency allocation is selectively designed.

It is necessary to use the (ISM industrial scientific and medical) band that is excluded on the examination table for various reasons such as development convenience. Korea allocates 917 Hz to 923.5 MHz to the RFID

/ USN band used in the ISM band. This band is included in the frequency band of our system. Therefore, 917 to 923.5 MHz can be selected, and a band from 920.9 MHz to 923.3 MHz in which various transmission outputs are guaranteed is used. The channel spacing was 125 kHz. As shown in Fig. 2, the external case power source was applied to the solar cell panel.

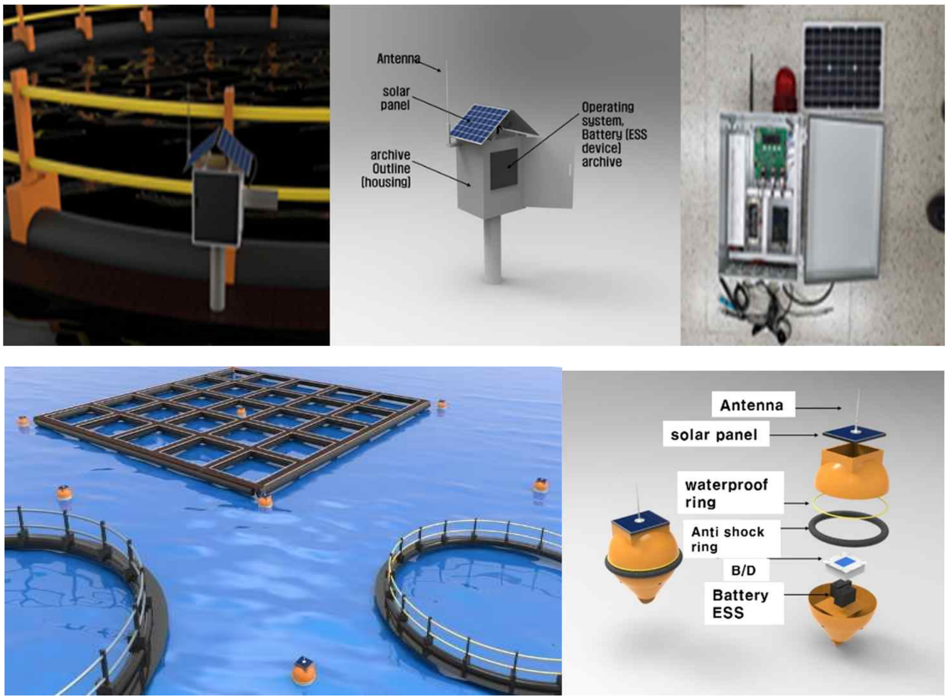

Fig. 2 buoy and gateway configuration

Fig. 3 **Hardware module manufactured in buoy**

Figure 3 shows the LoRa-based module hardware built into buoy and host. It is roughly divided into a sensor section and a communication section. The sensor unit consists of an environment sensor that collects atmospheric and ocean environment information, and an IMU sensor that reports wave movement and buoy direction. The communication part was made up of a GPS communication module and LoRa communication module for receiving and receiving the position of buoy.

2.2. Design and manufacture of gateway

It shows the overall structure of the gateway hardware.

Fig. 4 The manufactured hardware of the module built in G/W.

Figure 4 shows the gateway hardware and the overall gateway. The gateway is connected to the buoy and LoRa channels and serves to collect information from buoy. The configuration consists of MCU, LoRa, power supply unit, communication unit (Wifi/BT), OLED display unit, and input unit. One gateway must design a MAC frame structure that can communicate with more than 100 Buoys in order to observe them.

The MAC frame structure is based on the LBT (listen before talk) method. And the TDD star network was formed based on the frame control slot transmitted from the gateway. And in the SE-alloc field, the upper/lower link was designed to be variable.

We designed a function to detect only the buoy signal of the owner and a function to detect the information sent by the buoy.

3. Results and Analysis

This chapter details the range testing and simulations performed on the South Sea. LoRa base designed and produced in this paper, this may be a solution to prevent us fish from domestic farm fishermen.

3.1. Environment

Here, the test environment and the basic contents of the test are summarized.

- Test venue: Ocean near Namhae City, Jeollanam-do
- Test content: Buoy communication distance and unit function test
- Test target: Buoy 4EA

The gateway was installed on the rooftop of the second floor, and the gateway and Local Server (BackEnd) configured data communication using wireless communication (Wifi). A total of four buoy modules were used in the test. A communication distance test and simulation were performed with four buoys to which each ID was assigned. Each buoy that has been given an ID from 1 to 4 times is equipped with a communication module, GPS module, atmospheric/ocean sensor module, etc.

3.2. Experimental method

The LoRa range test was conducted at a nearby farm. After arriving at the measurement position, the gateway and buoy were operated to check whether the communication was with the gateway. In order to determine if the communication between the farm and the sea was lost, the first action was to check whether the communication was in the farm. When it was judged that the communication was smooth, the department collected the floating data on the sea.

The gateway connected to the Server and Wifi and confirmed receipt of the data. Displayed data from PC and Android via server. As a push function of Android, fishermen easily receive the latest data. The latest data comes to the top of the GUI. The connected buoys are managed so that they are displayed separately for each channel, and the buoys are matched with GPS and displayed on the map. Atmosphere and environment information values sent via buoy are now sent to Numeric.

4. Result

The communication distance test was conducted separately for land and sea. The land-based communication distance test results confirmed that all four buoys on land with a distance of about 6.6 km communicated normally with the gateway. The received signal strength of the measured buoy signal was measured between -92 dBm and -103 dBm.

The offshore communication distance test results confirmed that all four buoys communicate normally with the gateway at a distance of about 5.2 km. The received signal strength of the buoy signal was 97 dBm and 107 dBm. In order to confirm the atmospheric and marine environment sensing functions, four buoy data reception values were confirmed. As shown in Fig. 5, we confirmed that all data such as water temperature, salinity, dissolved oxygen content, GPS, 9-axis IMU value, carbon dioxide, fine dust, radioactivity, etc. are received in more than 107 dBm century.

Fig. 5 atmospheric environment monitoring

The communication distance test was conducted separately for land and sea. In the land-based communication distance test, the received power was confirmed to be within 120 dBm at the 6.6 km point.

Communication is considered to be possible within the buoy distance of 5.2 km within the farm. Tests to gradually increase the distance such as 10 km and 20 km will be required. It was confirmed that the unit function (simulation) of buoy received the values of the atmospheric and environmental sensors without loss.

5. Conclusion and future research direction

Based on the communication test distance of buoy, the difference between the predicted value and the actual measured value was compared and analyzed. The feasibility of communication was examined by comparing the link budget calculated by the test according to the measurement distance with the actual measurement.

As shown in FIG. 5, the test results reveal that the theoretical calculation of buoy and the measured values are almost the same. The received signal due to the link budget at 10 km is theoretically 127 dBm.

Considering that the designed MDS of buoy is 132 dBm, it is judged that there is no problem even for 10 km communication.

In the future, it will be necessary to add and use artificial intelligence functions for big data analysis and atmospheric environment prediction.

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