양식장 환경 데이터 모니터링 및 예측 시스템의 설계

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Design of the Environmental Data Monitoring and Prediction System for the Fish Farms

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요 약

본 논문에서는 바다 환경의 변화로 인한 양식장의 피해를 막을 수 있도록 양식장의 환경 데이터를 실시간 모니터링하고 기계 학습 기반의 예측 서비스를 제공하는 시스템 설계를 다룬다. 제안 시스템은 양식장의 주요 위치에 수소 농도, 염도, 용존 산소량 그리고 수온을 측정할 수 있는 센서들로 구성되는 사물인터넷 기반의 디바이스 모듈을 설치하며, 이들로 부터 수집한 데이터는 LTE 또는 LoRa 통신 기술을 이용해 클라우드 DB로 전송한 후 웹사이트나 모바일 애플리케이션을 통해 실시간으로 양식장의 환경 데이터 모니터링을 가능하게 한다. 아울러 수집된 데이터를 활용한 기계학습 기반의 예측 기술을 적용해 양식장의 환경 변화에 미리 대비할 수 있도록 하는 기능을 가진다.

ABSTRACT

In this paper, we design a system to monitor environmental data in fish farms in real-time and provide machine learning-based prediction services to prevent damage on fish farms caused by changes in the sea environment. The proposed system will install an IoT device module consisting of sensors that can measure hydrogen concentration, salinity, dissolved oxygen, and water temperature, which can be transferred to Cloud DB using LTE or LoRa communication technology and then monitor the real-time condition through a web or mobile application. In addition, it has a function to prepare for changes within the environment of fish farms by applying machine learning-based prediction technology using collected data.

키워드

Fish Farm Environmental Condition, Monitoring System, Prediction System, Mobile and Web Application

Ⅰ. Introduction

Due to the annual red tide phenomenon, many countries, such as Korea, suffer significant economic losses in the aquaculture sector [1]. The red tides with a massive number of algae consume large amounts of oxygen in the water and indirectly kill fish by describing the oxygen in the water [2]. Such in Gyeongnam regions such as Geoje, Tongyeong, and Namhae, many fish farms are at risk of dying a group of fish due to red tide every year.

The problem is caused by red tide in fish farm environmental conditions that makes monitoring water conditions very important because it can affect fish production [3]. Many studies attempt to reduce environmental problems by applying related technologies such as sensors to detect water conditions [4]. Even though they have already used technology to check the water condition, they must

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do it directly on the spot since it is not an online service. Meanwhile, if changes in water conditions occur and the position of the fish farm owner is not in place, this system still cannot help them.

This study proposes to design a monitoring system that provides real-time notification to fishers when the level of dissolved environmental conditions at an appropriate location in the fish farm falls below the allowable level. The goal is to provide information on farm environment conditions and prediction services by introducing service functions, IoT device communication, cloud DB, machine learning, mobile applications, and web applications technology.

The remainder of this paper is organized as follows. Section II illustrates the system model, section III, describes the design of the monitoring system, section IV describes the challenge and the issue, while section VI presents the conclusions.

II. Architecture of the Proposed System

2.1 The Architecture of the System

This section describes the architecture of the proposed system. A fish farm with an installed IoT hardware module records the environmental condition in the fish farm. The server responds to a request and saves the data. The owner is provided with a mobile and web application to check the fish farm environmental condition status, including statistic data and a prediction system. Figure. 1 illustrates the architecture of the proposed system.

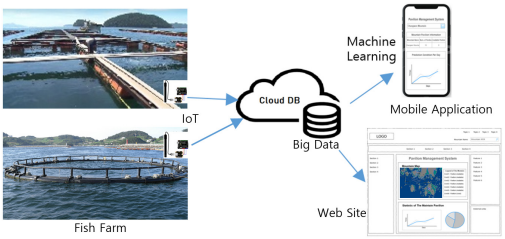

Figure 1. The architecture of the proposed system

2.2 Requirement of the System

Several categories must be considered to design this fish farm monitoring system, such as hardware, communications, server, application, and predictive system requirements. Table 1 lists the detailed requirements of the system.

Table 1. Basic requirement of the system

Category	Requirements
IoT Device	Raspberry PI, and multiple sensors such as hydrogen concentration oxygen, salinity and temperature
Communication Module	LTE or LoRa
Server	Firebase database
Mobile and Web Application	Code editor: Visual studio (java) and sublime (php, javascript, css), and web browser
Prediction System	Machine Learning Algorithm

IoT device is to detect environmental conditions in a fish farm. The communication module is to handle the exchange of data between the hardware module to the database. The database server collects data from multiple sensors and presents it to the user side. Mobile and web applications provide the owner with real-time information regarding the fish farm's environmental condition. In addition, the prediction system identifies the possibility of future environmental conditions in fish farms based on historical data.

III. Design of Fish Farm Monitoring System

3.1. Hardware Module

A hardware module is installed with four sensors to detect environmental conditions, such as hydrogen concentration, oxygen, salinity, and temperature sensors. Moreover, Raspberry PI is a computer board that connects all hardware and transfers data from hardware to database using LTE or LoRa as a communication module.

3.2. Database Design

The database design includes four entities: Location in which to explain the position of the fish farm, Sensor is containing information about the conditions of the fish farm at a certain time in each location of the fish farm, Parameter that is to describe the estimation of the expected status/level values for hydrogen concentration, temperature, oxygen, and salinity in seawater in fish farms; the last one is User it is described the user account's information (for the security side).

3.3 Mobile Application

The function of this mobile application is to display information about the environmental condition and prediction system of the fish farm on

the mobile phone of the owner. Figure 2 illustrates the mobile application of the system.

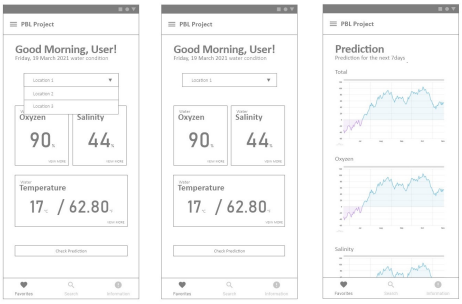

Figure 2. Illustration of mobile application

3.4 Web Application

The function of this web application is to display information about the environmental condition and statistical data of the fish farm. Figure 3 illustrates the web application of the system.

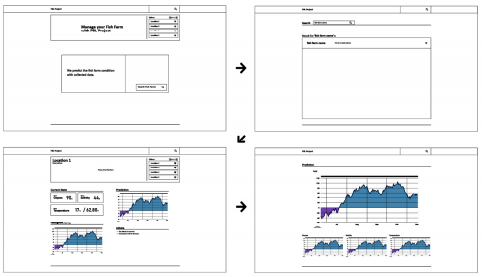

Figure 3. Illustration of web application

Ⅳ. Issues and Challenges

The main issue for aquaculture is data transmission technology, which can be challenging as the distance between the fish farm and the mainland and the sea weather conditions are quite extreme. Hence, determining the correct communication system so that the flow of transmitted data is not disturbed and the information service operates properly is required.

When monitoring the environmental conditions of the farm using hardware modules, the problem is the supply of energy that is difficult to obtain because it is located far from the mainland. The challenge is how to provide an always-available, easy and safe supply of energy suitable for the sea environment.

Another issue is how to create a predictive system with high accuracy to detect environmental conditions in a farm that usually change very fast. The challenge is to determine the correct prediction techniques and algorithms to make the best prediction system that best suits the conditions of the fishing environment.

Ⅴ. Conclusions

In this study, we develop a system that can determine the environmental condition in the fish farm by using a sensor to detect environmental condition such as hydrogen concentration, salinity, oxygen, and temperature level, divide the functionality as a hardware module, cloud DB, mobile and web application as a user interface. Information about environmental conditions such as location information, date and time, hydrogen concentration, salinity, oxygen, temperature level, prediction status, and statistical data in the fish farm will help the owner monitor their fish farm in real-time to increase their production.

For future study, we want to implement the system with appropriate tools and communication data using LTE or LoRa, implement mobile and website applications with full function, and machine learning such as regression method to predict near-future conditions possible for advanced monitoring of a fish farm.

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