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

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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.

KEYWORDS

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

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
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](image)

Table 1. Basic requirement of the system

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

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 due to 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.

References


