Telementry System Design for Fish Pond Water Quality Monitoring Based on Internet of Things

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Abstract: Water quality is the main parameter in the success of fish farming. As a place for fish to live, changes in the physical parameters of water can directly affect the growth and survival of fish. Therefore, fish farmers need to make regular observations of the condition of the water in aquaculture ponds and then provide certain treatments so that the water conditions remain in accordance with the prerequisites for the growth and development of the cultivated fish. Fish farmers observe water conditions by taking pond water samples to be observed in the laboratory or using handheld sensor equipment. This mechanism requires a lot of time and money. In addition, it also requires the presence of farmers continuously in the cultivation pond, which of course makes it difficult for farmers, especially if the size of the cultivation pond is large. In this study, a water quality monitoring system for freshwater aquaculture ponds based on Internet of Things (IoT) technology was designed. The working principle of the system is to send data from several water quality sensors (pH, turbidity, temperature, salinity, and water level) through an embedded system to a cloud service. Fish farmers then can monitor pond water quality using their PC/smartphone. The main contributions of this article are: propose an integrated system with weather forecast services and telegram message notifications.

1 INTRODUCTION

Indonesia is a maritime country consisting of thousands of islands with an area of 3977 miles between the Indian Ocean and the Pacific Ocean. Of this area, 75% is ocean and 25% is land. With these geographical conditions, the fishery sector is one of the potential sectors to support the Indonesian economy (Junaidi & Kartiko, 2020). The fairly high demand by neighboring countries such as Malaysia, Singapore, Japan and China for various types of consumption fish should be a great opportunity for Indonesian fishermen and the fishing industry to meet the market demand. Domestically, based on data released by the Ministry of Maritime Affairs and Fisheries of the Republic of Indonesia, the level of fish consumption rose from 47.34 kg/capita/year in 2017 to 54.50 kg/capita/year in 2019. In 2021, this figure will increase to 55.56 kg/capita/year, and is projected to continue increased in the following years (Perikanan, 2022). In terms of potential employment, the aquaculture sector in 2030 is projected to create 8.9 million new jobs, which is an increase from the current figure of 2.7 million jobs (Phillips et al., 2016).

The increase in the fisheries sector in Indonesia has not been matched by the development of adequate science and technology. For example, in cultivating fish, many farmers do not know the cause of the sudden death of fish. The main factor that determines the success of fish farming is water quality. Physical parameters that can be observed to describe water quality include temperature, acidity (pH), dissolved oxygen and salt levels (Chien, 1992). As a place for fish to live, changes in these physical parameters can directly affect the growth and survival of cultivated fish (Junaidi & Kartiko, 2020; Manoj et al., 2022). Each type of cultivated fish has different prerequisites for water conditions in order to grow optimally. Fish will live and breed well if the environmental conditions provided in accordance with their living conditions can be met or close to their natural habitat. Therefore, fish farmers need to make regular observations of the condition of the water in aquaculture ponds and then provide certain treatments so that the water conditions remain in accordance with the prerequisites for the growth and development of the fish being cultivated.

The results of the study show that about 60% - 70% of the causes of dead fish in aquaculture are

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caused by poor observations of water quality (Boyd, 1990). About 80% of aquaculture still uses manual methods in observing water quality (Lannan et al., 1986). Water quality cannot be observed with the naked eye, to make observations, farmers take aquaculture pond water samples and then take them to the laboratory or use handheld sensor equipment. This mechanism requires the presence of farmers periodically in fish farming ponds. In addition, it also takes a long time and costs a lot (Ismail et al., 2020; Manoj et al., 2022). For laboratory tests, the costs range from Rp. 10,000/parameter/one test to Rp. 200,000/parameter/one test. While handheld sensor equipment, prices start from Rp. 1,500,000 to Rp. 7,000,000 per test parameter.

Based on these problems, the authors propose a design of a water quality monitoring system for aquaculture ponds that can transmit data on physical parameters of water quality in real time without requiring the presence of farmers around the pond. Parameters observed consisted of pH, turbidity, temperature, salinity, and water level. This system will also utilize data from weather forecast service providers, because rainwater is indicated affect water quality. In addition, there is a warning notification feature if the water condition crosses the safe threshold if the farmer does not want to check the PC/smartphone regularly.

2 DESIGN

Based on previous research, there are several shortcomings, including: the average water quality monitoring system only uses one node, the physical parameters used to measure water quality are few, the protocol has not used a low size and bandwidth efficient protocol, the data obtained is not stored and processed, then no integration with other service providers. In this study, a water quality monitoring system for fishpond was designed that could be developed in terms of quantity (scalable). The prototype of the device to measure the physical parameters of the water quality of aquaculture ponds in this study also uses a more complete sensor. This system uses the MQTT protocol to be able to transmit data in real time. This protocol is known to be suitable for devices with limited capabilities (embedded) and efficient communication of power and bandwidth. Then, not only monitoring, the measurement data can also be stored for big data purposes. In addition, the system is designed to be able to connect with other service providers such as weather forecasting, messaging, and others. The system architecture design proposed in this study can be seen in Figure 1 below.

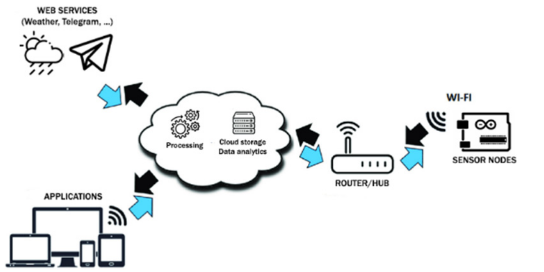

Figure 1: Architecture of Fishpond Water Quality Monitoring.

The proposed monitoring system consists of three main parts: a collection of sensor nodes, a router/hub device and a cloud service. The following is an explanation of each of these sections.

2.1 Sensor Node

The sensor node is a device that observe the physical parameters of fishpond water. This device is placed directly on the observed pool object. Broadly speaking, this device is composed of three components, namely: a microcontroller as a computing device, a sensor to observe the physical parameters of water and a communication module to transmit the observed data to the gateway device. The design of the device can be seen in the image below.

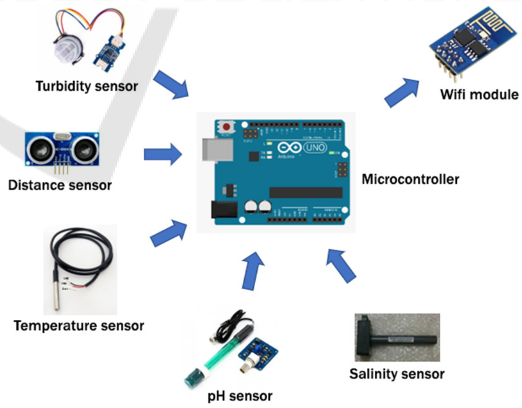

Figure 2: Sensor Node Component.

To be able to measure temperature, author uses the DS18B20 sensor, measures distance using the SR04 ultrasonic sensor, measures water clarity using a turbidity sensor, measures salt levels using a conductivity / salinity / TDS sensor, and to measure the degree of acidity or base using a pH meter sensor. Meanwhile, to transmit measurement data, the author uses the ESP8266 wifi module.

2.2 Router/Hub

This device has a role to receive data from observations of the condition of aquaculture pond water from all sensor node devices. The data is then sent to the cloud via the internet for further data processing and presentation.

2.3 Cloud/Service

This section has a role to collect, store and process data from observations of physical parameters of fishpond water. The data that has been stored and processed can then be accessed by fish farmers through a web-based application. Not only that, the application is integrated with weather forecast services and message notification services. The following is a design view of the application to be built.

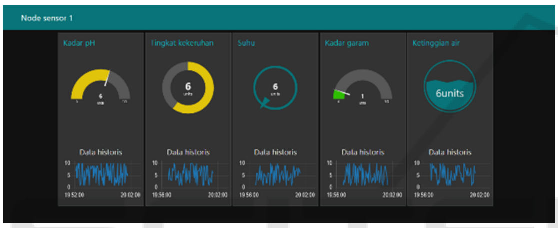

Figure 3: Web Application to Monitor Water Quality.

3 METHOD

The internet of things-based telemetry system for monitoring fishpond water quality was developed using a prototyping methodology. Protoyping is a methodology in which an initial prototype with the main functionality is built, then presented to the user, the user then provides input so that the resulting device is truly in accordance with the wishes and needs of the user (Despa, 2014). Figure 4 below shows the flow.

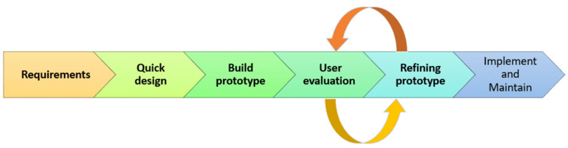

Figure 4: Prototyping Methodology Steps.

Changes and presentation of the prototype can be done many times until an agreement is reached on the form of the software to be developed. The advantages of the prototyping methodology are: it is best when goal is not well understood, it is useful when client is not technically not well, requirement may be added while developing software, and it is most flexible model for developing software (Chandra, 2015).

4 CONCLUSIONS

The design of fishpond monitoring and measurement system using an IoT is designed and proposed to assist fishpond farmers in monitoring the water quality of their ponds. This model is intended to alleviate the problems through manual monitoring, such as tedious testing and exhaustive inspection due to wet and spacious farming. Benefit from using the proposed model includes more effective monitoring of the fishpond as the system can monitor the quality of the water in a timely manner and alert the fish farmers to detect water quality degradation. In this model, five parameters can be monitored, which are water temperature, pH, water level, turbidity, and salinity. With the help of the proposed design, the quality of water can be continuously measured and monitored to ensure the growth and survival of fish in ponds. As a result, preventive action can be taken in a timely manner to minimize losses and increase productivity.

The purpose of this study was to propose a model of fishpond water quality measurement and monitoring system based on the Internet of Things (IoT) in order for fishpond farmers to monitor the water quality of their ponds. Therefore, our future work will be to focus on the implementation of the system. Furthermore, the collected data can be analyzed using big data analytics, and preventive measures can be taken before the threshold range is crossed by the water quality parameter.

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