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Early Warning System of Water Quality Changes In Fishponds

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ABSTRACT

This study aims to develop an early warning system for changes in water quality in fish ponds using the MQTT and Telegram Bot protocols. Poor water quality can cause significant economic losses in fish farming. Therefore, a system is needed that can accurately and quickly detect changes in water quality and provide warnings to fish farmers. The method used in this study involves the installation of sensors that are connected to a microcontroller and a communication system using the MQTT protocol. The sensors used include temperature sensors, pH sensors, turbidity sensors, water level sensors, and salinity sensors. The data obtained from these sensors will be sent via the MQTT protocol to the server connected to Telegram Bot. Telegram Bot is used as an interface for users. This bot will receive data from the server and perform processing to evaluate the water quality in fish ponds. If a significant change in water quality parameters is detected, the bot will send an early warning to fish farmers via Telegram messages. Fish farmers can receive these alerts on their mobile devices, so they can quickly take the necessary action to improve water conditions. The results of this study indicate that the developed early warning system can provide fast and accurate warnings of changes in water quality in fish ponds. With this system, fish farmers can take the necessary actions to prevent losses caused by changes in water quality before more serious damage occurs. In addition, the use of Telegram as a communication platform allows fish farmers to receive alerts on their mobile devices, which increases the responsiveness and convenience of water quality monitoring.

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1. Introduction

The expanding global need for fish is being met in part via aquaculture, particularly fish pond management. However, due to a number of factors, such as shifting environmental conditions and water contamination, maintaining ideal water quality in fish ponds can be difficult [1]. To avoid potential threats to fish health and guarantee sustainable fish production, it is crucial to identify changes in water quality indices as soon as possible.

Several studies related to early warning systems for monitoring fish pond water quality have also been carried out such as Ya'acob, et al. a water quality monitoring system for fish ponds with IoT technology using temperature, pH, and ultrasonic sensors, as well as the Blynk application for notifications [2]. Rozie et.al. developed a water quality management system for catfish ponds by combining aquaponics and IoT technology, as well as controlling water quality using artificial intelligence fuzzy logic to control temperature and ammonia levels, as well as making it easier for farmers to monitor parameters of pH, Turbidity, Total Suspended Solids (TDS), Oxygen Dissolved, and Water Levels in real-time and can intervene directly if the pool water quality is not optimal [3]. Wardhany et.al developed a monitoring and control system for vannamei shrimp feeding using the Fuzzy Logic method based on measuring pH, oxygen, and pond temperature as a decision-making factor for automatic feeding schedules to increase the efficiency of feeding and growth of vannamei shrimp [4]. Rahman & Salim an automatic system for controlling pH, water turbidity, and temperature in aquascape using sensors and Wemos D1 Mini ESP8266 [5]. Pramana, et al. designed a water quality monitoring system for fish farming that can be monitored in real-time via an internet-based smartphone/PC application, equipped with an early warning system using the Robotdyn Uno Wifi R3 ESP8266 [6]. Alfiansyah, et al. designed a monitoring system for vannamei shrimp farming ponds based on the Internet of Things (IoT) and Early Warning System (EWS) that uses the Double Exponential Smoothing Holt method to predict potential hazards to pond conditions, with notification via Telegram chat [7]. Billah, et al. developed a real-time water quality monitoring system for fish farming using dissolved oxygen sensors, pH sensors, and water temperature sensors integrated with the CC3200 Launchpad microcontroller and the Internet of Things (IoT) platform to enable remote monitoring, and tested using habitat water quality simulations catfish [8]. Mardiyono conducted research on developing IoT technology by producing hardware that can be monitored through a web-based application. The method used in developing this application is the Software Development Life Cycle (SDLC) method with the Waterfall Model [9]. Other studies using MQTT have also been carried out such as Mukherji et.al. researches on smart farming techniques using the Internet of Things (IoT) and Message Queuing Telemetry Tracking (MQTT) to monitor the farm environment in real-time and collect data for proper maintenance of farmland to maintain optimal crop growth conditions, overcome irregular changes in rainfall and climate for farmers in India [10]. Another study was conducted by Budioko to develop node sensors to monitor river water levels using the FreeRTOS and MQTT protocols. The sensor node uses an ultrasonic sensor module and an LCD screen. The communication protocol between sensor nodes and monitor nodes uses MQTT. Sensor nodes can send data to servers and can be received on node monitors using the MyMQTT Android application and the MQTT Explorer desktop application [11]. A study developed a shrimp pond water quality monitoring system using the Node-Red platform and the MQTT protocol. The system uses sensors to measure dissolved oxygen, hydrogen potential, turbidity, water temperature, and water level. Data is sent to the server using the MQTT communication protocol. Data processing is carried out on the server using the IFTTT method and produces decisions in the form of commands to control the actuator on the actuator control node [12].

In this study, an early warning system is proposed that utilizes the MQTT (Message Queuing Telemetry Transport) protocol and Telegram bots for real-time monitoring of fish pond water quality. The system uses sensors connected to microcontroller-based devices to measure key water quality parameters, and data is transmitted to a central server via the MQTT protocol for analysis and processing. The Telegram bot acts as an intuitive user interface, allowing easy access to real-time water quality data and issuing early warnings to fish farmers in case of significant changes, enabling proactive decision-making to maintain optimal water quality conditions for fish farming.

The proposed early warning system provides real-time monitoring and alerts through the popular Telegram bot platform. System integration with the MQTT protocol ensures efficient and reliable data transmission, while the Telegram bot offers fish farmers an easy-to-use interface to access important information about the water quality of their fish ponds. By leveraging IoT technology and an instant messaging platform, this early warning system can significantly improve the efficiency and effectiveness of fish pond management, enabling fish farmers to take proactive actions to mitigate risks and optimize fish health and production.

2. Research Method

This section describes the research framework, architecture, and flow chart for the Early Warning System for Changes in Aquaculture Pond Water Quality.

2.1 Research framework

This framework includes phases like problem definition, literature review, system design, implementation, testing, and evaluation, data analysis, and conclusions with suggestions for future work on early warning systems for changes in the water quality of fish farming ponds. Figure 1 depicts the steps. The first step is problem identification, which seeks to identify issues with fish farming utilizing pond media. The results of the problem's identification show that the pool's water quality is unstable or that it fluctuates depending on pond conditions. Changes in temperature, turbidity, salinity, water depth, and water acidity are only a few of the factors utilized as indicators. The next step is to perform a literature review to compare

current research with hypotheses and earlier studies.
System design, which includes software and system architecture design, is the third stage. Implementation, or the creation of software, is the fourth stage. Trials and evaluations are then conducted to produce findings and suggestions.

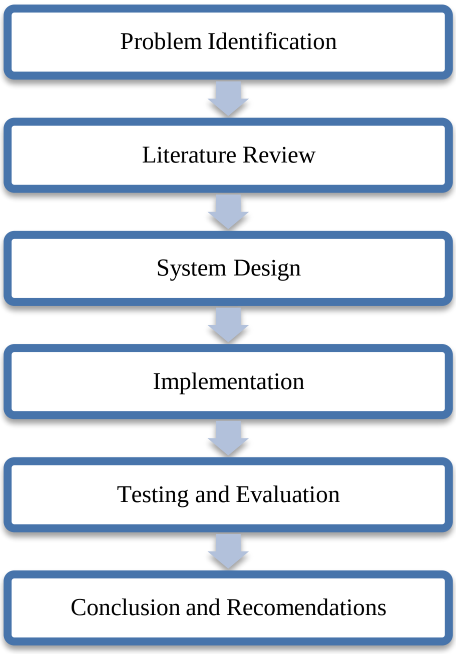

Figure 1. Research framework

2.2. System Architecture

The following components make up the early warning system the author suggests for ponds used for fish farming: 1. Sensor nodes, which are components positioned around fish farming ponds and comprise an Arduino microcontroller fitted with five sensors to measure pH, temperature, turbidity, salinity, and water level, as well as a WiFi module for data transmission; 2. Middleware is an intermediary piece of software that runs on the cloud and is used to gather, store, process, and display data as well as connect to Telegram's chat and weather forecasting services. Utilize the Node-RED auxiliary tool with this middleware. An open-source programming tool called Node-RED enables users to build flows that process data from several sources and transfer it to various destinations. It is a visual programming tool that lets users drag and drop nodes to build flows on a website. Each node stands for a certain task, such as gathering data from sensors, processing it, or transmitting it somewhere. Node-RED can be used to control greenhouse climate [15], monitor environmental factors in food crop cultivation [16], and program the flow of water quality data from sensors to Telegram via the MQTT protocol [11, 13–14].

Figure 2 depicts the system architecture that was developed.

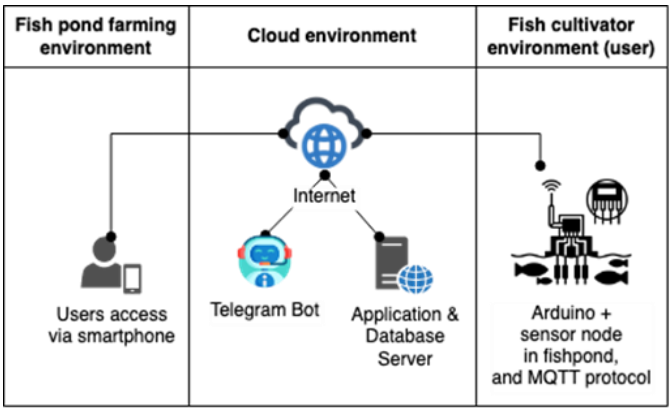

Figure 2. System Architecture

2.3. System Flowchart

The sensor node is where the system workflow begins. As shown in Figure 2, the microcontroller first calculates and processes data from sensors for pH, temperature, turbidity, salinity, and water level. The data is then collected and sent to the cloud via the WiFi module using the MQTT protocol.

Sensors that detect different parameters, including pH, turbidity, dissolved oxygen, and water temperature, can be utilized to monitor water quality in an early warning system utilizing the MQTT protocol. Using the MQTT communication protocol, data from sensors can be processed by a microcontroller or sensor node and delivered to a server [17]. The data can then be processed by the server, which will subsequently generate commands to operate the actuator on the actuator control node [13,18]. Real-time data transmission is also possible to web services and mobile applications [17,19]. Checking the water's turbidity and pH levels can also be used to calibrate the system [20]. When the quality of the water fluctuates between normal and high, normal and low, low to normal, or The technology can telegraph a warning to the cultivator's cellphone when the level rises above usual..

Early alerts can be sent to fish farmers' phones using Telegram bots. Sensors, such as ultrasonic sensors, that notice changes in the environment, such as the disappearance of crucial parts like lights, batteries, and solar panels in fish gathering devices, can activate bots [21]. In cloud computing networks, bots can also be utilized as a notification system for intrusion detection and prevention [22, 23; 2]. Bots can be activated to detect gas leaks using sensors like the MQ2 sensor, which notices a leak and sends a warning message to the user's smartphone via the Telegram app [24]. Because they can be trained to do so, bots are a useful tool for early warning systems.

To monitor the water quality of aquariums and shrimp ponds in aquaculture, bots can send push messages using the MQTT protocol [13]. In this investigation, Telegram bots were used to issue warnings to growers via their mobile devices.

The data is received and processed in accordance with the topic (Figure 3), as shown in Figure 2, using middleware that has been placed in the cloud. For instance, if a sensor node broadcasts to the pH topic, middleware that has previously subscribed to the "water-telemetry/node1/ph" topic will receive data. The web page's dashboard will graphically present the data provided by the middleware, after which it will be determined whether or not it is still within acceptable bounds. For fish farming purposes, this threshold is derived from SNI [25]. Figure 4 illustrates the reasoning behind verifying the data that was received.

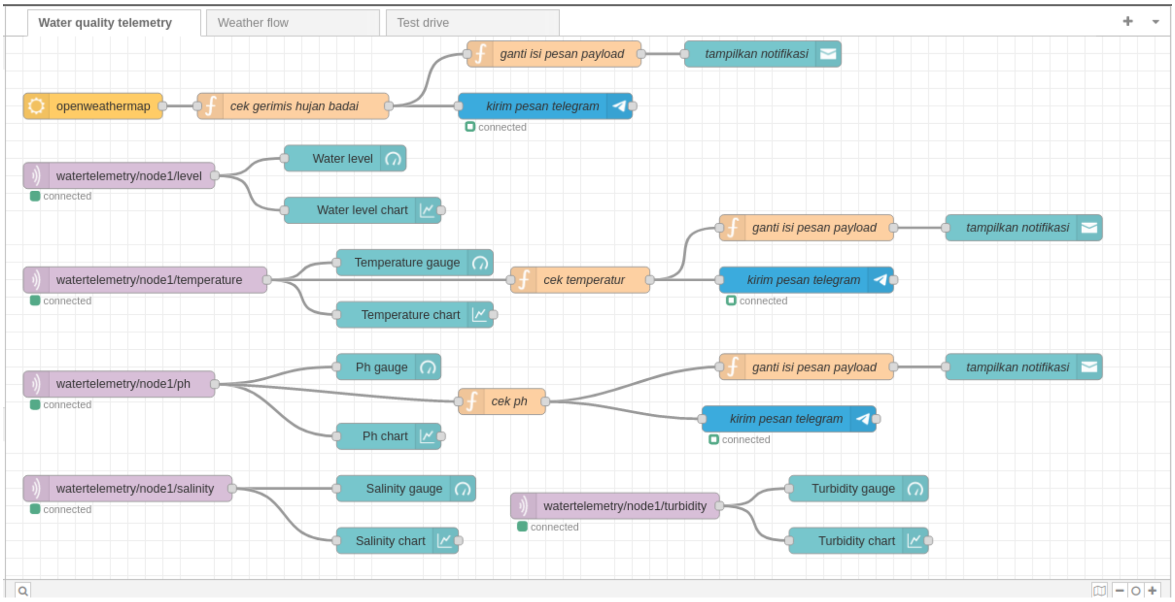

Figure 3. The middleware's flow of data

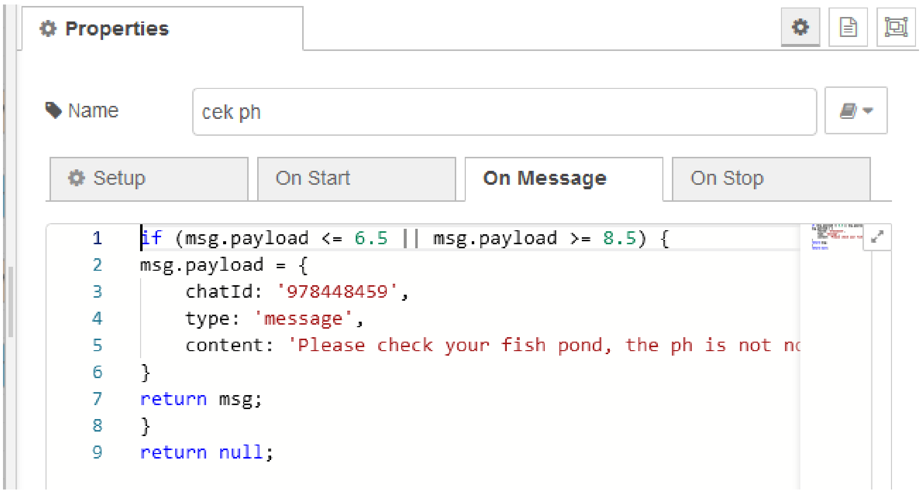

Figure 4. The logic of checking threshold conditions

3. Result and Discussion

Figure 5 shows a test activity done in a controlled setting where water is provided with pH powder. The goal is to see if the system can measure accurately or not, and if it can, whether it can test the early warning system's functionality. Figure 6 shows an illustration of an early warning telegram that would be delivered if the water pH value exceeded a threshold (pH 4.00), the temperature was unusual, and rain was predicted.

Figure 5. Testing in the lab

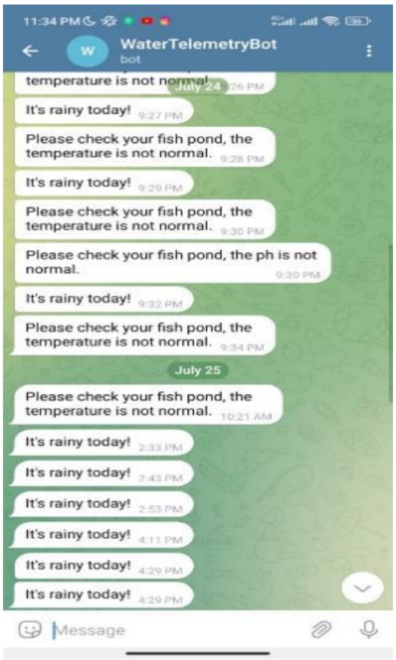

Figure 6. Telegram is provided as an early warning.

Figure 7 depicts how the system is tested when it is used in close proximity to a fish farming pond. There was no early warning notification since the water in the fish farming ponds was normal at the time of the study and not close to the threshold.

Figure 7. fish farming ponds conducting direct testing

4. Conclusion

The study's findings suggest that the developed system is capable of displaying data from sensor nodes in real-time in graphical form related to a number of physical factors affecting water quality. Real-time integration of the system with the open weather service is possible. If the data collected by the sensor node is close to the typical threshold for quality water, the system is able to alert farmers beforehand via notification displays on the web page dashboard and telegram messages.

In order to prevent water splashing on electrical components, better packaging of sensor nodes will be required in the future. This will make them more tidy and portable. Additionally, for calibration reasons, the results of measurements using manufacturer's tools or laboratory tests on fish pond water quality parameters need to be compared with the results of sensor node readings.

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