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Prototype of Water Quality Monitoring for Grouper Fish Pond Based on Microcontroller Arduino

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Abstrak

Prototype monitoring kualitas air tambak kerapu dimaksudkan untuk meningkatkan kualitas air tambak kerapu jika terjadi perubahan kualitas udara seperti keasaman, suhu udara dan tingkat kekeruhan udara yang dapat disebabkan oleh ikan atau ikan yang dapat digunakan pada pernafasan ikan. ikan yang dapat membuat ikan menjadi stress dan tidak dapat berkembang biak dengan baik serta dapat menyebabkan kematian pada ikan. Untuk mengatasi permasalahan tersebut diperlukan suatu teknologi yang dapat mempelajari dan mengontrol kualitas udara sesuai dengan standar, selain itu juga dapat memfasilitasi petani tambak untuk memfasilitasi kualitas udara tambak dan proses otomatisasi standarisasi indikator kualitas air. Pengembangan ini menggunakan hal-hal terkait internet dalam komunikasi data antara prototipe dengan petani tani. Model pengembangan yang digunakan adalah prototype. Untuk proses pengujian, (3) uji coba dilakukan: (1) pengujian evaluasi, dengan hasil pengujian prototipe, mendapatkan persentase 100% dengan kategori sangat efektif. (2) pengujian validitas, dengan margin error sebesar 4,38% dan hasil pengujian sensor secara keseluruhan di bawah 4,38%. (3) uji kepraktisan, diperoleh hasil 92,2% responden menyatakan bahwa pemantauan prototipe ini sangat praktis.

***Keywords**: Kualitas Air, Tambak Ikan Kerapu, Mikrokontroler, Arduino*

Abstract

Prototype monitoring of grouper pond water quality is intended to improve the water quality of grouper ponds if there is a change in air quality such as acidity, air temperature, and air turbidity level, which can be caused by fish or fish that can be used on fish breathing fish that can make fish become stressful and cannot multiply properly and can cause death in fish. To overcome these problems, a technology that can be studied and controlled according to the standards is needed. It can also facilitate pond farmers to facilitate pond air quality and the automation of standardization of water quality indicators. This development uses internet-related matters in data communication between prototypes with farm farmers. The development model used is prototyping. For the testing process, (3) trials are conducted: (1) evaluation testing, with test results, prototypes, get a percentage of 100% with a very effective category. (2) validity testing, with a margin of error of 4.38% and the overall sensor test results under 4.38%. (3) practically test, obtained by the results of 92.2% of respondents stated that monitoring of this prototype is very practical.

Keywords: Water Quality, Grouper Fish Pond, Microcontroller, Arduino

1. INTRODUCTION

Fish farming activities in Indonesia, especially groupers, have very good prospects because grouper has fairly good domestic and export markets (Gunawan et al., 2004; Koniyo & Kasim, 2017). In addition, the price of groupers is quite stable and increases due to international prices, and grouper prices are largely determined by the relatively stable Hong Kong and Singapore markets (Budiasa et al., 2018; Fatimah et al., 2020; Ghufran, 2010). Grouper aquaculture plays a role in fulfilling the needs of grouper consumption, increasing income and providing employment for the community, and preserving scarce marine fish resources. One of the supporting factors for the success of fish farming is water quality. Good

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water quality will cause the growth of cultured grouper to be optimal (Ghufran, 2010; Sambora & Waluyanti, 2016).

Grouper habitats are in coral reefs or clean waters with high salinity levels of 30-35 ppt; maximum carbon dioxide is 10ppm, oxygen levels are above four ppm, seawater temperature is 27º - 32º C, acidity is 3 to 4.5 ml, NH_3 and NH_4 are low (<1 ppm), the acidity (pH) of seawater is 7.6 - 7.9. The turbidity level is greater than 3.5 NTU. In addition, the nitrite content should not be more than 0.1 ppm. The ideal water flow rate is around 20-40 cm/second where this speed is needed for the change of water, oxygen, and drainage of the remaining fish metabolism and outgoing fish feed (Ardiwijoyo et al., 2018; Ghufran, 2010; Harel et al., 2019). According to pond farmers, the most critical indicators affecting the quality of the grouper fish are 4, namely, the level of acidity (pH), salinity (salt content), temperature, and finally, the brightness level in the water (Alamsyah & Nurcahya, 2019; Ghufran, 2001; Pulungan et al., 2020).

According to local pond farmers who have the development of grouper aquaculture in the area of Buleleng Regency, more precisely in the Gerokgak sub-district. These areas include Musi, Sanggalangit, Penyabangan, Banyupoh, and Yehbiu Villages. However, according to Farmers, management of grouper cultivation is not effective. The reason is that pond farmers cannot continue to monitor changes in water quality, so if there is a change in water quality and if the handling becomes too late, it will adversely affect the growth of groupers so that the grouper production will not be optimal. Changes in water quality are caused by several factors, one of which is the weather. When the weather is hot, the water temperature will increase, causing fish to become stressed. When it rains, the acidity (pH) of the water will be low. In addition, the level of turbidity is high because there is a suspension of colloidal soil/grime, which is very dangerous for fish. These particles can stick to the fish's gills and damage and disrupt fish breathing. However, according to the salinity farm farmers, it does not affect the fish grouper because the pond's water source has come directly from the waters in the sea, which is the original habitat of Grouper.

Technology is needed To overcome this problem. The technology needed in the grouper cultivation process is a technology that can know and control the system. Before implementing the technology used in grouper cultivation, a prototype is needed. The prototype serves to implement conditions in the field in an image form (Abiyaksa et al., 2020; Erten & Özdilek, 2018; Ghufran, 2001). In addition, the prototype facilitates the development process. Similar devices have also been developed (Indriani et al., 2017; Indriani & Fajri, 2019). This prototype device monitors two parameters, namely temperature and salinity in shrimp using ATMEGA328. Monitoring results will be displayed on smartphones configured with Bluetooth. This is not effective because the prototype does not take action when temperature and salinity change. Farmers have to do traditional ways to regulate temperature and salinity to suit shrimp habitat.

Another device also developed similarly monitors acidity (pH) in koi fish. The sensor will measure the predetermined state of the equation. The device will automatically circulate the aquarium if it crosses the threshold. This is not yet effective considering that in water quality, other indicators such as temperature and turbidity significantly affect the development process of koi fish, and the data obtained by sensors cannot be stored (Ahmad & Suprianto, 2019; Nasir et al., 2016; Rahmanto et al., 2020). In addition, some developments resemble devices. The device monitors pH and temperature levels in the cultivation of Sangkuriang catfish and automatic feeding. This device monitors the pH and temperature levels in Sangkuriang catfish farming and takes action when getting results that do not meet the standards. In addition, this device can also provide automatic feeding to catfish, making it easier for pond farmers without the need to feed traditionally. The development of this prototype was ineffective because the monitoring results were carried out the data obtained could not be saved (Qalit et al., 2017; Rahmanto et al., 2020). The contribution of this study from previous research is integrating the technology used in previous studies. This technology is still separate. The author combines the overall technology used to be more effective to be implemented. Besides that, in this development, the data is stored in a database to use the data to be explored.

2. METHOD

The research method used to develop a prototype for monitoring the water quality of Arduino microcontroller-based grouper ponds is the prototyping method. Stages in the prototyping method include selecting needs, building prototypes, evaluating prototypes, coding systems, testing systems, and evaluating systems. In the stages of selection of needs, the authors make observations at the location of fish farming to find out what is needed in fish farming. After knowing what needs are needed, then searching for data and references on designing a prototype tool to detect temperature, turbidity, and pH, assemble these components to run well. Stages of building prototypes are building applications appropriately (prototype), at this stage, making devices quickly, focusing more on input/output devices following the general needs known in the first stage. This stage produces the prototype. After the prototype is produced, the next stage is the evaluation of prototyping.

The prototype evaluation stages, namely prototype 1, were submitted to the user to evaluate and discuss solutions to the constraints experienced during prototype preparation. At the stage of submission of the prototype, new information was obtained about the needs of the devices built later. If the evaluation results are inappropriate, the next step is to repeat gathering needs. Next is the system coding phase to get new information about application needs. The prototype is developed according to new needs. The results of the evaluation of the prototype become second prototype 2. By emphasizing the input/output process needed by the user. The process of coding this system is done in the Arduino IDE software. The next process is testing the system that has been developed. The results obtained are then re-evaluated.

Water Quality Indicator

The water quality indicator of grouper cultivation is a temperature that is good for the life of groupers ranging from 20 ° C - 35 ° C. However, the ideal temperature is 27 ° C - 32 ° C with no extreme changes. For example, in tropical climates in Indonesia, water temperatures are generally relatively high with very small changes. One of the things that are a problem is the presence of temperature stratification due to the absence of winds that move the water flow. Therefore, a diffuser type or pulp blower can be used or operated to anticipate this situation. The degree of equality (pH = negative puissance de H) is used to obtain a picture of the ability of water to produce mineral salts. The degree of acidity of water is determined by the concentration of H ions, which are represented by numbers 1 to 14. If the number is less than 7, it indicates that the atmosphere is acidic (low pH), more than 7, alkaline, while 7 indicates a neutral condition (Alamsyah & Nurcahya, 2019; Imaduddin & Saprizal, 2017).

Grouper cultivation is best done in waters with a pH of 7.6 - 8.9, which is the general range of seawater pH. A large amount of Ca and Mg ions in seawater causes seawater to be difficult to experience changes or fluctuations in pH, except in mangrove forest areas. But the normal pH of seawater is easily subject to change when inserted into the pond. The change in pH is caused by the influence of pond soil and the activity of organisms in the pond. Thus, pond land must also have an optimal pH. The cleanliness of pond waters is very important for the life of groupers maintained. The pond's turbulence can occur due to plankton, suspension, soil particles, humus, and iron hydroxide. Turbidity due to colloidal soil/mud suspension, especially iron hydroxide, will be dangerous for fish. These particles can stick to the fish's gills to damage and disrupt fish breathing. Turbidity that is good for pond water is greater than 3.5 NTU (eyes can look into the water as far as 45cm or more). Turbidity can be overcome by making control plots, planting water plants, and replacing water (Ghufran, 2010; Sambora & Waluyanti, 2016).

Prototype

A prototype is a tool used to simulate some or not all system features created. There are three main approaches to the prototype, (1) Throw-Away, prototypes made and tested. Experience gained from making prototypes is used to make final products. Then the prototype is discarded (not used). (2) Incremental, the final product is made as separate components of the final product design as a whole. There is only one but divided into smaller independent components. (3) Evolutionary, in this method, the prototype is not discarded but is used for the next design iteration. In this case, the actual system or product evolves from the very limited initial version to the final profile or final product (Abiyaksa et al., 2020; Michael & Gustina, 2019; Nasir et al., 2016).

Arduino

Arduino UNO is a microcontroller-based board at ATmega328. This board has 14 digital input/output pins (where six pins can be applied as PWM output), six analog inputs, a 16 MHz crystal oscillator, USB cable connection, a power jack, reset button. These pins contain everything needed to support a microcontroller only connected to a computer with a USB cable, or a voltage source can be obtained from an AC-DC adapter or battery to use it (Abiyaksa et al., 2020; Daulay, 2018; Nasir et al., 2016).

Turbidimeter sensor

A Turbidimeter sensor is a device used as standard test equipment to determine the level of turbidity of water. The existence of this tool is common and easy to find. This sensor is a light source sensor and light catcher, which is then passed to the part of the water that will be measured or checked for turbidity. This sensor can connect to the measurement instrument processing device such as the microcontroller or Arduino (Erten & Özdilek, 2018; Febtriko, 2017).

Temperature Sensor

Resistive Temperature Detector, abbreviated as RTD, has a function that can convert electrical energy into electrical resistance proportional to changes in temperature. The accuracy of Resistive Temperature Detector (RTD) is more precise and has higher accuracy. Resistive Temperature Detector is generally made of Platinum material, so it is also called Platinum Resistance Thermometer (PRT) (Erten & Özdilek, 2018).

pH Sensor

The pH sensor determines the PH value of the available liquid, while the limit switch will function as a determinant when the pH sensor moves up and down and shifts left and right. Data obtained from a pH sensor is sent to the microcontroller to be converted into digital data, which can then be done via LCD, which occurs very quickly. The pH sensor outputs in the form of a voltage, the more alkaline (pH value> 7), the sensor produces a smaller voltage, conversely if more and more the pH sensors produce a greater voltage (Erten & Özdilek, 2018; Rahmanto et al., 2020).

3. RESULT AND DISCUSSION

Result

The development of this design aims to produce a permanent design to facilitate assembling the components to be used. The following are the results of a permanent design that has been made. The function of making a flowchart is to describe the production processes so that they are easily understood and easily seen based on the sequence of steps from one process to another. In addition, it is also to simplify the process or procedure to facilitate the user's understanding of the information. The function of database design is to facilitate data processing, so the data needed can be retrieved at any time. There are three tables in the database: the temperature table, pH table, and turbidity table. Each of these tables has two fields, namely value and time. Figure 1 shows database design prototype water quality monitoring.

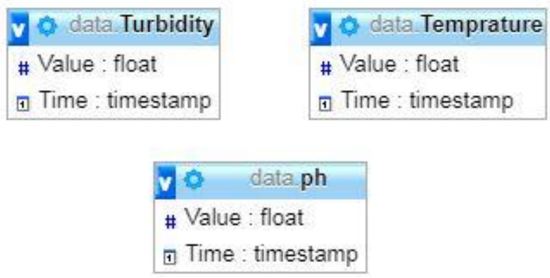

Figure 1. Database Design Prototype Water Quality Monitoring

Figure 2 shows the electronic design of the results of the analysis that has been carried out. Electronic design is needed as a guide or instruction in making electronic circuits developed so that it facilitates the process of developing a prototype.

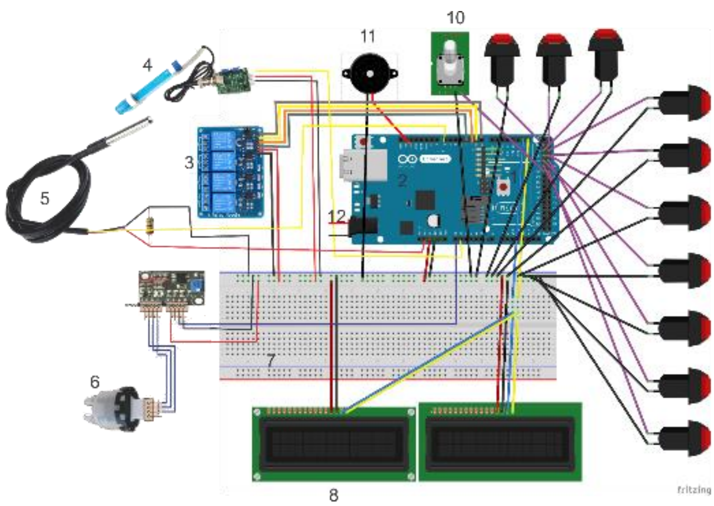

Figure 2. Tools Set Design Prototype Water Quality Monitoring

The explanation of the components in figure 3 is the Arduino microcontroller which functions as a regulator of other components, the Ethernet shield functions as connectivity to the server, the relay functions as a Sakar, set the device on / off, the pH sensor serves to measure the water level, the temperature sensor serves to measure the temperature water, turbidity sensor serves to measure the level of turbidity, the breadboard functions to facilitate the electronic coupling process, the LCD serves to display the readings from the sensor, the push button serves to set the desired standard water indicator, the switch serves to set the mode in the device, the buzzer as output sound that serves to provide notification, the power source functions as the power to run the device. Figure 3 describes the monitoring devices to be made; there are functions of each of them.

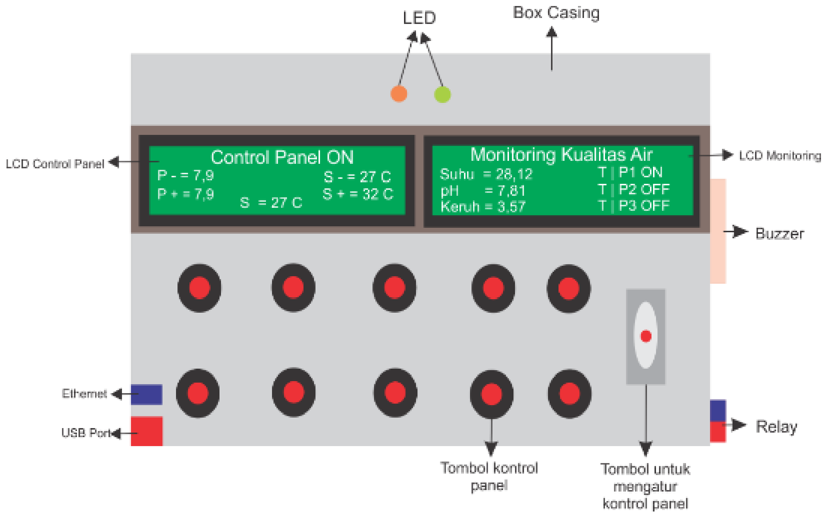

Figure 3. Prototype Device Design Prototype Water Quality Monitoring

The casing box serves as a container or house of all components that will be assembled; besides, it also serves to make components remain durable in the long term and make it easier for users to use these devices. The LED functions as a notification if there is a change in the quality of the fishpond's water, making it easier for the farmer to know the pond's condition. LCD Monitoring functions as a tool to inform water quality conditions and informs the status of each indicator and components that are running; Buzzer functions as a notification apart from LEDs in the form of sound, making it easier for farm farmers to know the condition of their farm, Relay, functions as a switch to turn on or deadly, the component used as an action of water quality indicator changes, the control panel control button, functions to activate or deactivate control panel mode, the control panel button, serves to increase or decrease the standard water quality indicator, USB port, functions as input power for Arduino microcontroller, Ethernet, functions as connectivity for the storage process to the database, LCD Control Panel functions as a monitor to facilitate the process of lowering or raising water quality indicator standards.

Architectural design is the overall design of a series of pre-prototype monitoring of grouper farms; this design provides ideas on how to work help identify problems from design. In addition, you can test various aspects you want to try. Figure 4 describes the design of a grouper water quality monitoring prototype. The design is a prototype framework that will be created. The prototype has several components, such as microcontroller units, sensors, water pumps, coolers, etc.

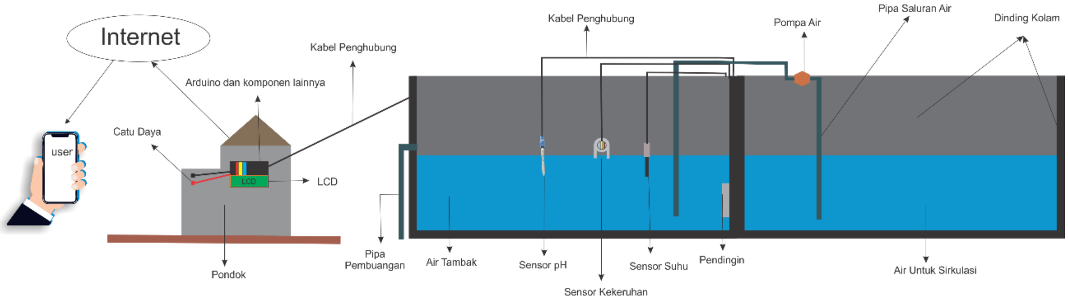

Figure 4. Architectural Design Prototype Water Quality Monitoring

The development phase uses two stages, hardware development, and software development. The hardware development stage is the stage to start assembling the design until all the components used by design have been made before. After carrying out the next hardware development stage, the software development phase includes creating programs to control Arduino and creating databases and tables. There are three tables in the database: the temperature table, the pH table, and the turbidity table. There are two fields in each of these tables: value and time, making a program for storing temperature, turbidity, and pH data, and making a chart for temperature, turbidity, and pH data.

Discussion

Effectiveness testing

Effectiveness testing is testing that is used to find out how far the desired goal has been achieved. This stage of effectiveness testing refers to the flowchart that has been made—starting from activating the prototype to storing data in the database. The questionnaire was given using two answers, namely right and wrong, with 20 respondents of pond farmers. Based on a questionnaire distributed to respondents to determine the effectiveness of the prototype using the Gutman approach, the results obtained are user responses stating that the results of testing the effectiveness of getting a percentage of 100% with a very effective category.

Validity Testing

Validity testing is a test to determine the accuracy of the water quality monitoring prototype. Testing this validity tests the accuracy of reading data from temperature sensors, turbidity, and pH. Testing is done by giving a questionnaire to the respondents. The testing process is carried out 50 times for each respondent. Based on the questionnaire that has been given to the farmer farmers, the average yield from the whole test is the average temperature difference of 0.023, the average difference in turbidity is 0.024, and the average difference in pH is 0.028. It is necessary to do calculations to find out the error margin of the test that has been done. Based on the calculations that have been made, the results show that the error margin is 500 times the experiment with a trust value of 95%, which is 4.38%. After knowing the value of the margin error, then determine the percentage error value. To determine the percentage value of the test, calculate it using the percentage error formula.

Practicality Testing

Practicality testing is testing to find out whether the prototype monitoring of grouper fish can be practical or not. This test was carried out by giving questionnaires to respondents, namely 20 pond farmers; each questionnaire contained ten statements, and there were five alternative answers, namely Strongly Agree (SS), Agree (S), Less Agree (KS), Disagree (TS), and Strongly Disagree (STS). Based on user response data, it is known that 92.2% of respondents gave the results that the prototype monitoring of the quality of the grouper fish ponds was very practical. The prototype serves to implement conditions in the field in an image form (Abiyaksa et al., 2020; Erten & Özdilek, 2018; Ghufran, 2001). In addition, the prototype facilitates the development process. Similar devices have also been developed (Indriani et al., 2017; Indriani & Fajri, 2019). This prototype device monitors two parameters, namely temperature and salinity in shrimp using ATMEGA328. Monitoring results will be displayed on smartphones configured with Bluetooth. This is not effective because the prototype does not take action when changes in temperature and salinity occur. Farmers have to do traditional ways to regulate temperature and salinity to suit shrimp habitat.

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4. CONCLUSION

Testing prototype monitoring of grouper farms based on the Arduino microcontroller got a good response from the usage prototype. The type of testing performed is testing, validity, and practicality. The results of these trials were carried out with the same results as 100%, besides that also tested the validity, carried out using all validity tests with a margin of error of 4, 38%, all tests of validity carried out managed to find a value below 4.38 % and can be a valid result. The last test was a test of the results that 92.2% of farm farmers felt that the quality of monitoring of grouper aquatic pond prototypes was very practical. Given that the Arduino microcontroller working system is not limited to multitasking, a process is underway. Namely, the process from monitoring mode to control panel mode, due to differences in the number of functional coding between monitoring coding mode and coding control panel due to a delay, do not need to be anticipated by another microcontroller.

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