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Model of Integrated System for Feeding Catfish and Monitoring Pond Temperature Based on IoT

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ABSTRACT

Indonesia is renowned for its rich biodiversity, including a diverse array of ornamental and consumable fish species. These fish are widely cultivated in aquariums, ponds, and cages, with prices varying greatly depending on the species. However, the current method of manual fish feeding remains inefficient and time-consuming. To address this challenge, an automated fish feeding system has been developed to streamline and enhance the feeding process. This research project was conducted using a simulation approach to lay the groundwork for a future prototype. The simulation involves an IoT-based model capable of providing automated feeding for catfish and monitoring the temperature of their pond. The system is designed for future implementation at Botani UPI, where traditional manual feeding methods are still prevalent. The primary objectives of this research are to automate catfish feeding and monitor the temperature of their pond. Feed will be dispensed according to a predetermined schedule stored in a database, allowing for flexible adjustments via the internet. Testing has demonstrated the successful operation of the website, fulfilling its core functions: adjusting pond water temperature as needed, automatically providing catfish feed, and scheduling regular feeding intervals. Users can control these functions remotely, enabling effective pond monitoring and management without physically being present at the site. The success of this testing underscores the immense potential of the integrated system to elevate catfish farming productivity and efficiency. By maintaining optimal pond temperatures, the health and growth of catfish can be better sustained, while scheduled and accurate feeding helps minimize feed wastage and ensures adequate nutrition for the fish. Additionally, the system reduces the manual workload for farmers, allowing them to focus on other aspects of pond management. Overall, the implementation of this technology not only offers economic benefits through increased production yield but also promotes more sustainable and modern fish farming practices.

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1. INTRODUCTION

Indonesia is proud of its biodiversity, one of them is the diversity of fish. Various types of fish are kept in aquariums, ponds and cages. The price of the fish itself has a high price depending on the type of fish. However, feeding the fish itself is still not conducive because feeding the fish is still done manually. Therefore, automatic feeding tools are needed to make feeding easier and more efficient. Feeding fish is one of the things that must be considered in order to produce quality fish. Regular and timely feeding is necessary to provide adequate nutrition to human resources. Fish feeding and provision cannot be controlled and monitored remotely. This requires constant checking of equipment to ensure that fish food can be provided automatically and in accordance with the feeding schedule for the various fish species available and that fish stocks are regularly checked. research on "Integrated System Model for Catfish Feeding and Pond Temperature Monitoring" where this tool will help in carrying out appropriate measurements based on scheduled times [1].

In fish cultivation, control systems such as Arduino can be applied to a tool for feeding fish. Then a device is created that helps in easing human work automatically, especially for fish pond entrepreneurs. This device can provide a sign if the feed supply is running low, making it easier for the owner. ponds in providing fish feed. However, the current use of the control system has several disadvantages, namely that errors often occur in scheduling and controlling the delivery of each feed. This will make fisheries managers unable to control scheduling and experience difficulties when providing feed, therefore here an integration process will be carried out for feeding by monitoring pond temperature [2].

Model system

Currently, technology has caused an increasing need for tools that can help all human activities. Technology will create many positive benefits in daily life [1]. The presence of technology will not rule out the possibility for humans to innovate and improve better performance in the fish cultivation sector, especially freshwater fish (catfish). One of the freshwater fish that has been cultivated commercially by the Indonesian people, many catfish farmers have to maximize the results of cultivation, even to the point of causing quite large losses. In fish life, the main medium is water, the good and bad of the interaction of water, land and air at the cultivation site. will determine the continuity of life, this interaction will determine and produce conditions for the success of the Ministry of Education & Culture. Technological advances nowadays are very beneficial for various aspects, including fish feeding systems [2].

Integrated system

System integration is a series of processes for connecting several computerized systems and application software, both physically and functionally. from catfish farming activities from the title raised, "An integrated system model for feeding catfish and monitoring pond temperature" namely Internet of Thing (IoT) based" is by feeding fish automatically and can be controlled remotely as well and can be giving the feed dose according to the temperature of pond. In this way, it is hoped that this device can improve feed dosage adjustments and efficiency in fish farming businesses. So the timing of feeding can be adjusted and give warning if temperature is not suitable to feed. Moreover, fish entrepreneurs can save feed to carry out work and produce fish of the desired quality [2].

Catfish feed

Fish feed is a mixture of various food components (raw materials) which are processed in such a way that they are easy to eat, digest, and can be used as a source of nutrition for fish when produced. Catfish are fish that really need proper feeding management to avoid the process of cannibalism between catfish in the pond. Another benefit of feeding management is that the conditions in the pond are maintained so that the waste substances released are controlled. So that catfish can grow effectively and get big quickly, there are several things that must be considered when feeding the catfish. First, measuring the feeding of catfish is done by taking into account the age of the catfish being cultivated. Effective scheduling of feeding for catfish is done twice a day, in the morning (08.00-09.00 am) and in the afternoon (04.00-05.00 pm) (Kurniawan Wahyu, Rizal Achmad, and Istiqomah, 2023).

Fish pound temperature

An important factor that influences the growth and survival of fish is temperature. Previously, many updates had been made to overcome this problem, which explained the design of a tool that could feed fish automatically and detect the temperature when it was in an abnormal state. Apart from that, there is also research on a tool that can display the temperature measured from the DS18B20 sensor, monitor water clarity from the LDR sensor and provide fish feeding based on the time set on the RTC. Testing of the fish feeding automation system includes testing the DS18S20 temperature sensor which functions to monitoring the condition of the water temperature, where the results of the temperature sensor readings will be a reference for

the amount of feed that will be given to the fish, testing the HC-SR04 ultrasonic sensor which functions to measure the amount of feed in the feed tank, testing the load cell sensor which functions to weigh the weight of the feed that will be released , RTC which functions as a timer module for fish feeding time, testing servo motor 1 functions to determine the ideal degree of opening of the plate valve in the feed tank, testing servo motor 2 functions to determine the ideal degree of motor rotating the feed container after weighing it towards the holding container and testing the motor dc functions to determine how far the feed is thrown, where each input step can be seen via the LCD [3]. Optimum temperature of the catfish pool is 25-32 degrees Celsius [4].

Monitoring

Monitoring is defined as a cycle of activities that includes collecting, reviewing, reporting, and acting on information about a process that is being implemented (Mercy, 2005). The monitoring system in this research is a tool that can carry out real-time monitoring of the water quality of catfish cultivation ponds using ESP32. The indicator used is pool water temperature [5].

Internet of things

Internet of things (IoT) is a concept that aims to expand the benefits of a continuously connected internet connection. The working principle of IoT devices is to provide objects in the real world that can be multiplied and represented in a computer system in the form of data. IoT technology is divided into 3 architectural layers, namely the perception layer, network layer, and application layer [6].

2. METHOD

This research was carried out simulatively as a prototype reference for further research. To create this simulation, an IoT model was designed that can provide food for catfish and monitor the temperature of fish ponds. The research is designed to be implemented at UPI Botany in the future because the condition of fish farming at Botany still uses manual or unsystematic methods.

Target

The target of this research is feeding catfish and monitoring the temperature of catfish ponds. Feed will be given on a scheduled basis based on schedule data stored in the database. Thus, if there is a change in the feeding schedule, farmers can do it flexibly via the internet. In addition, pool temperature monitoring receives data from temperature sensors sent via the internet. In this way, farmers can monitor the condition of the pond even though they are not there.

Subject

Because of the relationship between temperature and feed, pond temperature stability needs to be considered so that feed can be provided on a regular schedule. The limitations of this research are maintaining temperature stability and regular feeding schedules.

Procedure

Problem analysis

Problem analysis was carried out by observing the condition of catfish farming at UPI Botany. Apart from observations, interviews were also conducted with the parties responsible for the livestock. After being interviewed, literacy of scientific articles related to fish and ponds, especially related to catfish, was carried out. To implement it using IoT, literacy is also carried out on IoT topics related to the implementation of IoT in fish farming.

Based on the analysis carried out, it was found that there was a gap between the method of cultivating catfish and the technology used. Fish cultivation is still done manually, not yet automated using technology. On the other hand, there is no system that is able to maintain stable pond temperature so that the fish's hunger level still tends to follow the pond temperature. As a result, giving food that is not timely can have a negative impact on the fish itself.

Needs analysis

Based on the problems above, an integrated system for feeding and monitoring pond temperature is needed. This system can be implemented via IoT. The Processing Unit is used to process data received from sensors and servers. The sensors used are sensors that are able to provide up-to-date data on pond temperature and feed capacity. The server will provide data in the form of data that will be processed through commands to the actuator. These actuators will open the feeder to provide food to the fish and regulate the temperature of the pond.

Based on these needs, an ESP32 is needed as a processing unit that is capable of receiving data from sensors, moving actuators, and providing data to the server via the internet. Because the data is sent from the processing unit to the server, the protocol used is MQTT.

The sensors used are HC-SR04 and DS18B0. HC-SR04 is used to obtain feed height data in the feed container so that the current feed capacity can be known. DS18B0 is used to obtain the latest water temperature data.

Apart from that, actuators are also used in the form of servos, fans and heaters. The servo is used to open the lid of the fish food container so that the food falls into the pond. Fans are used to lower the pool temperature if the pool temperature is too high. If the pool temperature is too low, a heater can be used to increase the water temperature.

The server is used to process data received from the processing unit and forward or receive data from the client. The database used on the server is SQLite because the data used is not large and does not require complex processing so it is efficient to use. In addition, to handle data sent using the MQTT protocol, Mosquitto is used. So that the client can interact with the server, a web is used which will also interact indirectly with the processing unit.

System planning

The system design for integrated catfish feeding and pond temperature monitoring is centered on a cloud-based architecture that integrates various components to achieve efficient catfish feeding and pond temperature monitoring. The ESP32 microcontroller functions as the system's central processing unit, responsible for collecting data from sensors, controlling actuators, and communicating with the cloud. It is connected to other components via the ESP32's Wi-Fi capabilities. Temperature Sensor (DS-18B20) This sensor measures the water temperature in the catfish pond in real-time. It connects to an ESP32 microcontroller, providing continuous temperature readings. The sensor (HC-SR04) measures the water level in the catfish pond, ensuring that the dispenser is positioned appropriately for optimal feed distribution. It is connected to an ESP32 microcontroller and provides water level data. The servo controls the movement of the dispenser, ensuring proper feed distribution to the catfish. It receives commands from the ESP32 microcontroller based on feeding schedules and water level data. The Fan and Heater work together to regulate the pool temperature. The fan is activated when the temperature exceeds a predetermined threshold, while the heater is activated when the temperature falls below a certain level. Both are controlled by an ESP32 microcontroller based on temperature sensor readings. Cloud Server (MongoDB, Web Service, Feed) The cloud server stores and manages system data, including temperature readings, feeding schedules, and feed inventory. It also provides a web interface for users to monitor and control the system remotely. Websocket facilitates real-time communication between the ESP32 as microcontroller and cloud servers, enabling continuous data exchange and system updates.

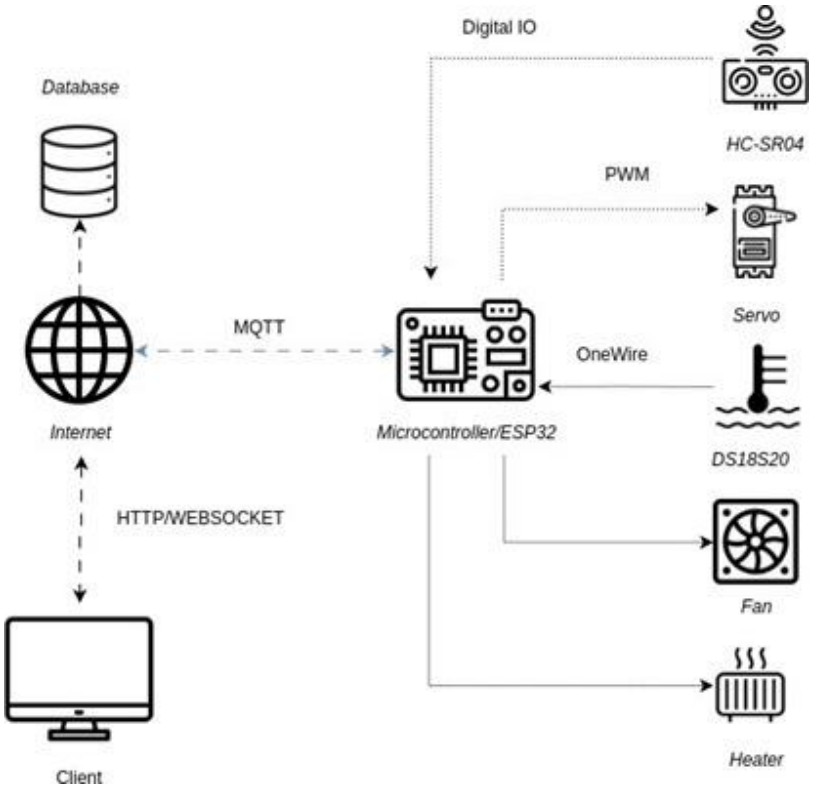

Figure 1. Architecture diagram of integrated system for feeding catfish and monitoring pond temperature

Controller Units are ESP32, HC-SR04, DS-18B20, Fan, and Heater. Server side components are web app and database: SQLite. Web will get data from the database and show them as charts to the client. Web and client use HTTP protocol to communicate, but will get messages from MQTT using a web socket. So, data provided by ESP32 will show and process realtime. Web gets temperature and amount of feed data from ESP32 by using MQTT protocol. Web also provides messages to increase and decrease temperature, and open or close the cap of the dispenser.

On the other hand, ESP32 gets dispenser vacancy data from HC-SR04. ESP32 will communicate with HC-SR04 with digital IO .That data will be processed on the web to get an amount of feed. ESP32 also gets temperature data from DS-18B20. ESP32 will communicate with DS-18B20 with onewire protocol. Temperature data will be sent to the web to process, so the instruction of all actuators is not according to the data that get from HC-SR04 and DS-18B20, but from messages that got from MQTT. ESP32 will get a message from MQTT to move the servo if it gets a message to open the cap of the dispenser. ESP32 communicates with servo with PWM protocol. To increase the temperature, turn on the heater until the temperature is normal. Likewise for the fan component. Turn on that component if you get a message to turn on one of the components and the temperature you want to get.

If the temperature is not normal, the client will get a warning to not give feed. The priority of the system is to stabilize the temperature before giving the feed. If a dispenser vacancy is critical, the client must fill in the dispenser.

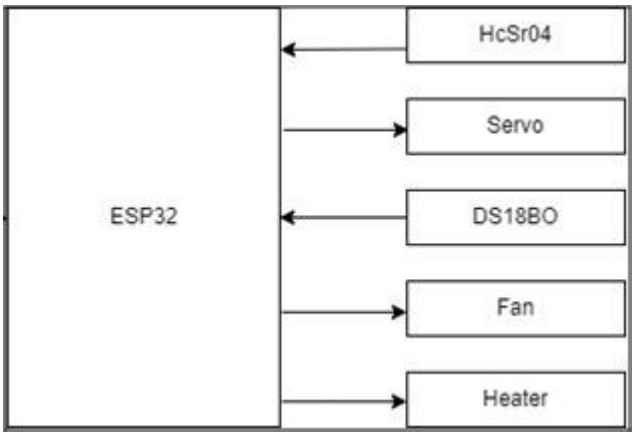

Figure 2. Block diagram of integrated system for feeding catfish and monitoring pond temperature

ESP32 gets temperature data from DS18B0 and gets the amount of feed from HC-SR04. ESP32 will provide temperature data in units of time to the web server through MQTT protocol. ESP32 only turns on the fan and heater if you get a message to turn on the fan and the heater from MQTT. The servo is used to feed to the fish pool. It will move the cap of the dispenser, so the feed can come out from the dispenser and vice versa. It will not move, if not get a message to move the servo from MQTT. From HC-SR04 we get the distance from the maximum amount to the current amount. ESP32 provides that raw data to web applications.

System implementation

The system is implemented using ESP32, HC-SR04, Servo, DHT11 as DS18B0 representation, blue LED as Fan representation, red LED as Heater representation, and personal computer as server and client representation.

The program implemented on the processing unit is a program that manages the interaction between sensors, actuators and servers. Therefore, the C++ language is used in the processing unit because it is capable of communicating with the machine.

Meanwhile, the program implemented on the server is a web program that manages client interaction and the processing unit. The web is chosen so that users can use the interface system to interact with the web server. Javascript is used to build web applications because the system needs to get data constantly.

System testing

System testing is carried out to ensure that the system works well and meets all specified requirements. The testing carried out is functional testing which includes:

a. Temperature Increase Test where the input target temperature is higher than the current pool water temperature. The system is monitored to ensure that the water pump is on and the feed dispenser is off. The pool water temperature is monitored until it reaches the target temperature. The system is turned off after the target temperature is reached.
b. The temperature lowering test is given an input target temperature that is lower than the current pool water temperature. The system is monitored to ensure that the water pump is off and the feed dispenser is off. The pool water temperature is monitored until it reaches the target temperature.
c. In the feeding test, the feeding time input is given. The system is monitored to ensure that the water pump is off and the feed dispenser is on. The feed dispenser is monitored to ensure that the feed is distributed to the catfish. The system is turned off after the feeding time is complete.
d. Feed scheduling testing creates a feeding schedule on the mobile application. The system is monitored to ensure that the water pump is turned off and the feed dispenser is on according to the predetermined schedule. The feed dispenser is monitored to ensure that the feed is distributed to the catfish according to the predetermined schedule. The system is turned off after all feeding schedules are completed.

3. RESULTS AND DISCUSSIONS

This research develops and tests an integrated system model for feeding catfish and monitoring pond temperature which is controlled via a website. This system is designed to increase efficiency and accuracy in managing catfish ponds by utilizing IoT (Internet of Things) technology. Test results show that the website is successful in carrying out main functions such as raising and lowering the pool water temperature according to needs, providing catfish feed automatically, and setting regular feeding schedules. Users can control all of

these functions remotely, allowing for more effective pool monitoring and management without needing to be physically present at the pool location.

Tabel 1. Tested table

No	Tested	Result
1	Show temperature on web	Web can get temperature data time by time from microcontroller and can visualize that correctly
2	Increase temperature from web	Client can increase temperature by turn on the heater from button on web correctly
3	Decrease temperature from web	Client can decrease temperature by turn on the fan from button on web correctly
4	Show current amount of feed on web	Web can get distance of empty dispenser and can visualize that correctly
5	Feeding fish from web manually	Client can feed catfish remotely by web correctly
6	Feeding fish automatically based on database	Microcontroller can feed catfish by message from server correctly
7	Prevent to feeding if temperature is not normal	Web can prevent microcontroller to feed by prevent to send message to microcontroller correctly

The success of this test shows the great potential of the integrated system in increasing the productivity and efficiency of catfish cultivation. With optimally controlled pond temperatures, the health and growth of catfish can be better maintained, while scheduled and accurate feeding helps reduce feed waste and ensure adequate nutrition for the fish. This system also reduces the manual workload for farmers, so they can focus on other aspects of pond management. Overall, the application of this technology not only provides economic benefits through increasing production yields, but also advances more sustainable and modern fish farming practices.

4. CONCLUSION

This research succeeded in building an integrated system for feeding catfish and monitoring pond temperature using the Internet of Things (IoT) for feeding catfish at UPI Botany. This system includes the use of sensors to measure parameters such as temperature, pH, water level and designing an integrated automatic fish feeding mechanism. The development of an IoT-based system provides a solution in feeding and cultivating catfish which allows real-time monitoring of environmental conditions and more optimal feeding. The performance of the monitoring system is a test of the functionality and accuracy of sensors showing that the integrated system for feeding catfish and monitoring pond temperature IoT-based can operate well.

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