Cerdika: Jurnal Ilmiah Indonesia, Januari 2025, 5 (4), 1401-1410
p-ISSN: 2774-6291 e-ISSN: 2774-6534

Available online at http://cerdika.publikasiindonesia.id/index.php/cerdika/index

DESIGN OF AUTOMATIC FEEDER WITH ADJUSTABLE TEMPERATURE, PH, AND WEATHER FOR CATFISH

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Abstract
Catfish is a fish that is consumed by many Indonesians and is one of the business opportunities. This can be a good prospect for the future with catfish farming. Even many restaurants and restaurants use this fish as one of the menus. Cultivating catfish is not easy, there are many parameters that need to be considered so that fish life can develop properly. Starting from sufficient water ph or according to the standard of living catfish, up to the air temperature. These factors will affect if catfish farms are ignored. Timely feeding is also a major factor that can have sufficient nutrition. With an automatic fish feed system and water quality monitoring, farmers' problems related to water quality can be monitored using sensors. Feeding can be done via a telegram bot with certain settings as needed.

Keywords: automatic feeder, catfish, monitoring system

Article Info:
Submitted: 22-01-25 ***Final Revised***: 14-04-25 ***Accepted***: 16-04-25 ***Published***: 18-04-25

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INTRODUCTION

Catfish (Clarias Sp) is one of the freshwater fish with a high economic commodity (Meitiyani et al., 2020; Mulia et al., 2021; Puteri et al., 2021; Setyono et al., 2023). According to the KKP (Ministry of Maritime Affairs and Fisheries), data on the amount of fish production in Indonesia in 2020 is 347,511 tons, while the target for fish consumption in 2020 is 56.39 kg/capita/year (Ratnasari et al., 2021). Fishery is one sector that can support economic development in Indonesia. Fishery resources owned by Indonesia are diverse and have the potential to include capture fisheries and aquaculture. Fish farming techniques known in Indonesia include fish farming in fast-water pools, still-water ponds, and cages (Apak & others, 2018). This could be a potential development prospect in Indonesia. To maximize the income of catfish farmers, increase the number and area of ponds and develop cultivation businesses, apply good maintenance and cultivation methods, and expand market reach from individual consumers, traditional markets, restaurants, and modern markets (Rao & Srikanth, 2019). Technically, an area is said to be a minapolitan area, among other things, the source of income for most people is obtained from fishing activities, and all activities in the area are dominated by fishing activities, including cultivation and processing of fishery products (Wei & others, 2017).

A place of development will take effect when conditions are not as they should be. Water that can be used as a culture medium must meet a standard for the fish's life requirements. Water quality parameters important for cultured fish are temperature, pH, and dissolved oxygen. The optimum water temperature for fish appetite is between 22 and 29 Celsius; at that temperature, the fish will eat voraciously, which happens in the morning and evening. Therefore, the best feeding is in the morning and evening (dan Perikanan, 2020).

If the temperature does not match the optimum temperature, it will affect the metabolic process of the catfish (Situmorang, 2017). Fish conditions can be disturbed due to insufficient nutrients, poor water quality, and high stocking densities. This condition causes the fish to become weak and susceptible to disease. Parasitic infections can also occur due to differences in the feed given, water conditions, and aquaculture activities (Jatnika et al., 2014). By using Internet of Things technology to monitor a situation that needs special handling from related parties by using the internet to send data and conduct control without any distance restrictions with the help of Arduino microcontrollers, so that it can be implemented in a remote monitoring system that will be applied to the pool catfish farming to accommodate monitoring of water conditions in catfish ponds by sending information on monitoring results such as information on time, water temperature, water pH, feeding status, volume of pond water filling and monitoring history that will provide information to the owner so that it can be done fast handling (Firdaus et al., 2019).

Feeding must be effective and efficient so that catfish can make good use of it for its growth (Wulansari et al., 2022). Temperature affects catfish survival, which are kept for 30 days at 200 fish/pond density. The initial weight of the catfish is 30 g. The survival rate of catfish during rearing was obtained from recording the number of fish that died each day and counting the number of fish that lived at the end of rearing. Fish culture systems with high stocking densities have the potential to cause stress, disease, stunted growth, and even mass mortality (Tuwitri et al., 2021).

The local catfish (Clarias Batrachus) is an omnivorous (everything) fish group. The main food of local catfish in their natural habitat is worms, water snails, maggots, larvae, insect larvae, water fleas, and aquatic insect larvae. The observation results show that the most significant percentage of local catfish food is water insects, 38%, and litter, 26%. In addition, fish scales, moss, and food debris were also found (Wildan & Ikbal, 2017). From this statement, catfish can also eat each other if the amount of feed given does not meet the fish's needs; this is what this research wants to solve.

Therefore, fish quality of life and adequate feeding are carried out so that fish growth can be good; then, continuous monitoring is carried out to get maximum results. A system to automatically feed fish and monitor PH and Temperature will be needed as a tool to support the needs of fish cultivators, especially catfish, which is relatively large in consumption in Indonesia. This tool will make it easier for farmers to feed and monitor catfish.

Related Work

This research Nuraisyah & Mukti (2022) proposed several applications, similar to developing an IoT device for an automatic feeder with automatic water replacement. However, it does not yet have a sensor to monitor the temperature and measure the pH of the water.

Research Jailani et al. (2020) also proposes planning a tool design for fish feeding, with the design having the aim of reducing the number of workers which reduces production costs, but only limited to automatic feeding of fish.

In this research Pratiwi et al. (2020) they proposed using Arduino Mega to create an automatic fish feed machine. This machine provides feed when no one is home. However, it still looks like the engine because there is no water or temperature monitoring.

Then Astriana et al. (2021) also discussed the same thing: how to redesign existing fish feed tools. Thus the material will be better and the cost is cheaper so that the durability of the machine will improve.

Propose Solution

This research proposes manufacturing an IoT-based automatic fish feed with a telegram bot as a controller and monitor. The machine includes a water temperature sensor and water pH to make it easier for farms to monitor the health of live fish media. The details of the design of this machine will be explained in the following section.

Sensors and Data

There are several sensors used to develop this IoT device. The first is a temperature sensor to measure water temperature, which will then provide information to someone to maximize the level of fish life based on water temperature. Then, the PH of the water, with the PH of the quality water, will affect the fish's quality of life. Increasing the PH of the food water increases the level of ammonia in the water; ammonia is toxic to fish.

One of the main challenges in catfish aquaculture is maintaining optimal water quality and feeding schedules, which are essential for fish growth and survival. Manual feeding and monitoring water parameters such as temperature and pH are time-consuming and often inconsistent, leading to poor fish health, decreased productivity, and increased mortality rates. Furthermore, the lack of real-time data and automation limits farmers' ability to respond promptly to changes in water conditions, especially in large-scale operations or remote locations.

Given the increasing demand for catfish as a food commodity in Indonesia and the potential economic value of the aquaculture sector, there is an urgent need to develop technological solutions that can improve efficiency in fish farming. Automation in feeding and water quality monitoring through IoT (Internet of Things) systems can address these challenges by providing accurate, timely, and remote management of aquaculture operations. Integrating innovative technologies is no longer a luxury but is necessary to ensure sustainability and competitiveness in the modern aquaculture industry.

A study by Ratnasari et al. (2021) developed an IoT-based automatic fish feeder and water replacement system. While the system succeeded in automating the feeding process, it lacked the integration of water quality monitoring sensors, such as temperature and pH, which are vital for maintaining fish health in real time.

Another study by Apak & others (2018) focused on the design and construction of an automatic fish feeder machine. Although it effectively delivered feed on a schedule, the study did not address environmental monitoring, limiting the system's ability to respond to fluctuating water conditions that could affect fish well-being.

Rao & Srikanth (2019) proposed an Arduino-based automation for pet feeding. While the system was beneficial in automating feeding when no one was home, it was tailored to pets and not aquaculture, and therefore did not consider essential aquatic parameters like dissolved oxygen or water pH.

Wei & others (2017) attempted to improve the design of existing automatic fish feeder machines by using more durable materials and reducing costs. However, like prior studies, the research focused solely on mechanical feeding improvements without incorporating any form of intelligent environmental monitoring.

While several studies have successfully developed automated feeding systems, most fail to integrate comprehensive environmental monitoring functionalities. Few systems monitor critical water quality parameters such as pH and temperature in real time, nor do they allow remote access and control. This research addresses that gap by proposing a fully integrated IoT-based system that combines automatic feeding with real-time environmental monitoring and remote control via a Telegram bot, providing a more complete and responsive solution for catfish farming.

The novelty of this research lies in its integration of an IoT-based automatic feeding system with real-time water quality monitoring and remote access via a Telegram bot, which has not been fully implemented in previous studies. Unlike earlier prototypes that focused solely on mechanical feeding or lacked environmental monitoring capabilities, this system combines key water quality parameters (temperature and pH) with automated feeding decisions. Additionally, Telegram as a user-friendly and widely accessible interface distinguishes this system by allowing users to control and receive updates without installing dedicated applications. This comprehensive approach provides a more responsive, intelligent, and accessible solution for modern catfish aquaculture, addressing both operational efficiency and environmental sustainability.

The main objective of this research is to design and develop an IoT-based automatic fish feeding system integrated with water quality monitoring, specifically focusing on temperature and pH levels, for catfish aquaculture. This system aims to optimize feeding schedules, ensure ideal water conditions, and enable remote monitoring and control through a Telegram bot. By combining these features, the system is intended to improve the efficiency and sustainability of catfish farming operations, especially for small- to medium-scale fish farmers in Indonesia.

The implementation of this system is expected to bring several practical benefits. First, it reduces the reliance on manual labor by automating feeding and monitoring tasks, lowering operational costs. Second, it enables early detection of suboptimal water conditions, thereby reducing fish mortality and improving growth rates. Third, using a remote-access platform empowers farmers to make timely and data-driven decisions regardless of location. Ultimately, this research supports the advancement of innovative aquaculture technology in Indonesia and contributes to more sustainable and productive fish farming practices.

RESEARCH METHOD

This research adopts the Waterfall development model as the primary methodology for designing and implementing the IoT-based automatic fish feeder system. The Waterfall model is a sequential software development approach consisting of five structured phases: requirements gathering, system design, implementation, verification and testing, and maintenance. In the requirements phase, data were collected regarding the needs of fish farmers, including feeding frequency and optimal water parameters. Both hardware and software components—including temperature and pH sensors, the Wemos D1 microcontroller, and a Telegram bot interface—were architecturally planned during the design phase. The implementation phase involved assembling the components and coding the control logic. The system's functionality was assessed in the verification and testing stage to ensure accurate sensor readings and proper actuator responses. Finally, the maintenance phase included monitoring system performance and making necessary adjustments. This method allowed for systematic development and ensured the final product met catfish farming's operational and environmental monitoring requirements. The research will be implemented in several steps, as shown in the scheme in Figure 1.

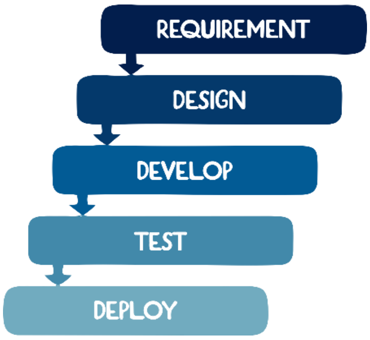

Figure 1. Waterfall Method

Waterfall is one method of software development. There are five steps in this development method, namely, requirements development at an early stage to collect information about the project to be built. The second is design, which involves designing applications and devices built from sketches and data flows. Implementation is the execution of applications that have been made. Verification and testing are tests carried out on the system. Lastly, maintenance, which is monitoring and repairing the damage that occurs, is also updated.

RESULT AND DISCUSSION

The System Requirements

The Development of IoT generally has the functional system as follows: (1) The system can automatically feed the fish, (2) The system can measure PH and Temperature for monitoring the water, (3) The system makes use of the microcontroller and the Wi-Fi module, which is connected to the internet. (4) The system can monitor the water quality from the device and check the quality every time.

Table 1. Standard Quality of Water

No	Parameters	Measure	Value
1	Temperature	Celsius	25-30
2	PH	ph	6,5-8
3	DO	mg/L	>= 3
4	Amonia	mg/L	<= 0,01
5	Water height	cm	25-40

Data in the Table. 1 is official data from the government related to catfish farming, with several parameters that can be used as guidelines to maximize water quality for fish survival (Senarath, 2021).

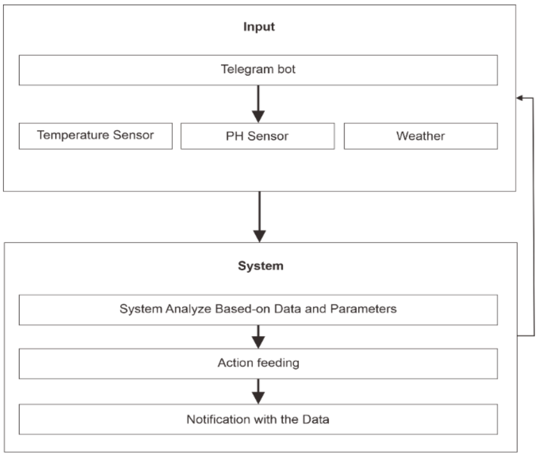

Figure 2. System Solution

In fig.2 The system to be proposed requires a telegram as a control panel and temperature, pH, and weather calculation sensors. With this sensor, the system will evaluate the input and provide feedback according to the analysis results.

System Design

The architectural solution in Fig. 3 has two main parts in the system. The IoT base section on the left is the section that will connect using the internet. On the right, there is a telegram bot as input by the user

The Internet is not always needed; the system can run on a local network if it is not possible to connect to the Internet.

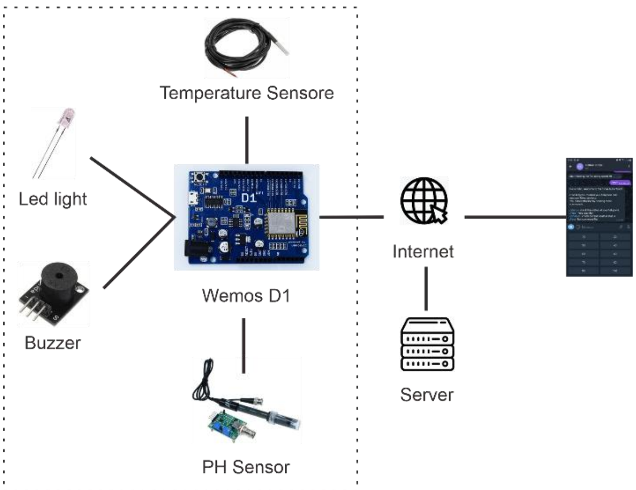

Figure 3. System Design Architecture

Several components in Fig. 3 develop this IOT, including: (1) Wemos D1 as a controller to control several device functions (2) Temperature sensor is used to monitor the water temperature (3) Led light is used as an indicator that IOT is running well or there is a proble (1) Buzzer is a sound information in detecting IOT is appropriately installed (2) PH sensor is used to measure the PH quality of water (3) A server is needed to provide feeding history data in datavase and analyze the data. (4) Telegram bot is used as a control to use the IOT and monitor the result

This device can monitor water conditions. Water quality. Water quality management was conducted in the morning and afternoon before feeding. The feed (fermented feed) was given in the morning, afternoon, and evening. The system can provide feed according to predetermined time settings.

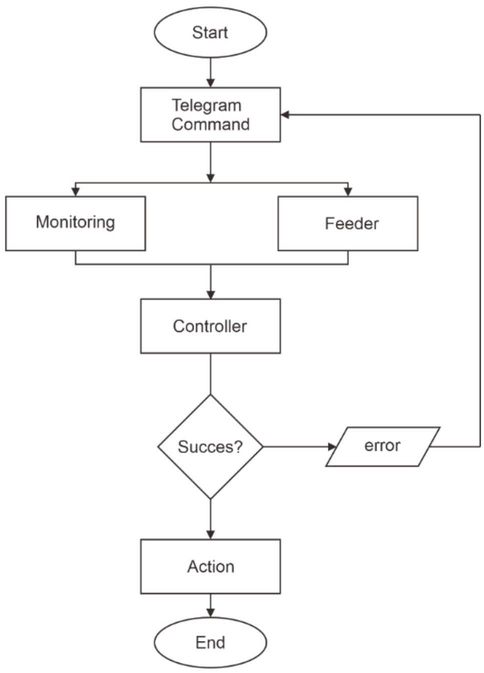

Figure 4. Flowchart System

From Fig. 4. Fish feeding and monitoring water quality can be done through the Telegram application only; users do not need to install other applications to use this IOT. With the Telegram bot, the fish feeding process can also provide direct feedback when the system has finished carrying out its duties.

The controller that acts as an analysis of several sensors can provide output in the form of a feed dose in accordance with the parameters that have been determined at the beginning.

Figure 5. Data Flow Diagram Level 0

According to the data flow that has been made, two main roles can control this system: employees and owners of catfish farming.

Develpotment

After making the hardware design, in this section, we will combine all these components into a single unit. Before combining each part, it is necessary to prepare the cover and place each component in the cover. All components, starting from the Arduino controller, PH, temperature sensors, and ejectors, are connected using a cable.

Figure 6. Prototype

Testing

Testing on the functionality aspect is assessed based on the results of the ability of each component to perform its function. Based on the command made by the telegram bot, the component will respond and determine whether the device can manage the command. If this IOT can work well as a whole, all aspects of the functionality of this product can be said to be feasible to implement. There is no need to repair when each component has no fault. The results of the functionality testing that has been carried out show that all components can work properly and continue to be implemented.

The developed IoT-based system successfully performed its intended functions, including automatic feeding and real-time water temperature and pH levels monitoring. The system responded effectively to commands sent via the Telegram bot and provided real-time data to the user, ensuring that feeding and water quality adjustments could be made promptly. These findings are consistent with the study by Ratnasari et al. (2021), which also utilized IoT for automation in aquaculture; however, their system lacked real-time water quality feedback. Compared to Apak et al. (2018), who focused solely on mechanical feeding automation, the present study provides a more integrated approach by combining environmental monitoring and user interaction via a mobile interface. Rao and Srikanth (2019) introduced a pet feeding automation system using Arduino, yet it was not adapted for aquaculture and lacked environmental consideration. The current study advances these earlier works by adding smart water monitoring sensors and remote control capabilities. This allows farmers to maintain optimal aquaculture conditions with minimal effort, thus increasing fish survival rates and reducing labor dependency. In summary, this research confirms the potential of IoT technology for feeding automation and as a critical tool for environmental control in sustainable catfish farming.

CONCLUSION

With this system, pool conditions can be maintained by utilizing the available sensors to obtain information in the form of temperature and pH, which can be seen anywhere and anytime. Feeding is made easier because workers do not need to come to the fish pond; it can be done remotely, so the system will automatically act according to commands on the Telegram bot. Improvements can be made through feed data and water quality information so that, in the future, analysis can be carried out using big data or artificial intelligence.

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