Implementation of IoT Technology for Optimization Shrimp Feeding in SMKN2 Kalianda Shrimp Ponds

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Abstract
Shrimp farming in Indonesia, particularly at SMKN 2 Kalianda, faces inefficiencies in manual feeding methods, leading to wasted feed and suboptimal shrimp growth. This research proposes an IoT-based automatic shrimp feeding system designed to address these issues by automating the feeding process and integrating real-time water temperature monitoring. The system utilizes the NodeMCU ESP8266 microcontroller, servo motors for feed distribution, and a DS18B20 sensor for monitoring water temperature. Data is communicated via HTTP to a web application, providing real-time monitoring capabilities. The system was successfully tested at SMKN 2 Kalianda's shrimp pond, demonstrating efficient feed distribution, with distances of up to 1.5 meters. It also ensured timely and accurate feeding, reduced labor costs, and minimized feed wastage. Additionally, the system can be further enhanced by integrating data analytics and machine learning to optimize feeding schedules and water quality management. These advancements promise to improve shrimp farming efficiency, reduce human error, and contribute to sustainable aquaculture practices.

1. Introduction

Shrimp farming is one of the most important forms of fisheries in Indonesia (Pradana et al., 2021). Efficiency in feeding is key to optimize production and reduce operational costs (Kusumo, 2024). Internet of Things (IoT) technology offers an innovative solution to monitor and control the feeding process in real-time and control the feeding process in real-time, thereby increasing efficiency and improve production efficiency and yield (Ristanta et al., 2021). Currently shrimp farmers at SMKN 2 Kalianda still use traditional feeding traditionally. The use of traditional feeding methods or called manual feeding is considered inefficient (Prayoga et al., 2023).The cause of the cause of this inefficiency is that when farmers feed, they often directly spread the feed in large quantities. They immediately spread a large amount of feed into the pond (T Atmaja et al., 2018).

According to research conducted by sasono, syamsul and prof sudato. If feed is removed in large quantities, the shrimp cannot eat the entire feed or part of the feed sinks into the water, resulting in loss of nutrients. or part of the feed sinks into the water, resulting in a loss of nutrients of up to 98 percent in just one hour

(Sasono et al., 2020). Shrimp feed requirements is a key parameter in determining shrimp health and smooth feeding (Waskitaadi & Nurmuslimah, 2023) . Automatic feeding system, with meticulously delivering feed directly to shrimp ponds, can significantly save feed significantly compared to conventional feeding methods conventional (Pauzi et al., 2020). Ensuring timely and accurate feed monitoring timely and accurate monitoring of feeding is indispensable (Setiawan & Surantha, 2023).

According to shrimp farmers at SMKN 2 Kalianda, the problem that is often faced in shrimp ponds is that the feeding is still done by the farmers often faced in shrimp ponds is that the feeding is still done manually, and sometimes the shrimp are not fed according to the schedule. manually, and sometimes the shrimp are not fed on schedule, so the shrimp cannot grow well the shrimp cannot develop properly. Therefore, it was created a system that can be run automatically. This system works using the concept of the Internet of Things. The author also created a web application for 2 IoT-based automatic monitoring of shrimp temperature is very important in optimizing modern aquaculture optimizing modern aquaculture. The proposed web application utilizes sensors to detect temperature connected to IoT devices, such as NodeMCU 8266, to measure temperature in real-time. The collected data will be sent to the server using HTTP communication protocol. Users can then access the web application through any device connected to the internet, such as a smartphone or computer, to monitor the water temperature in the shrimp pond. An IoT-based automated shrimp feeding system has several benefits, including significant feed savings, reduced operational costs, and increased fish yield.

1.1 Literature Review

According to (Ahmed et al., 2024) the automatic feeding system in shrimp uses NodeMCU ESP8266 as the main microcontroller. Servo is used as a driver to regulate the release of feed, while RTC DS3231 plays a role in scheduling real-time feeding. Electrical power is provided through AC voltage connected to a battery. This battery serves as a backup power source in the event of a power outage, so that the system can still operate. An energy controller is used to manage the flow of power from the AC voltage to the battery and to the feeding system.

Research by (Satra et al., 2024) revealed that the DS18B20 sensor is used to monitor the water temperature in shrimp ponds, which should ideally be in the range of 28°C to 31°C. The temperature data generated by this sensor is displayed directly through the 16x2 I2C LCD screen. With this feature, users can know the water temperature conditions in real-time, thus ensuring the pond environment remains suitable for shrimp growth.

As explained (Setiawan & Surantha, 2024), the technical specifications of the automatic feeding prototype include a detailed description of the components used. This includes sensor type, capacity, measurement capability, as well as details of the battery and energy controller. In addition, the system is equipped with a web-based monitoring feature that allows users to monitor pond conditions in real-time. These components contribute to the efficiency and operational sustainability of the system as a whole.

2. Research Methods

The prototype development of the IoT-based automatic shrimp feeding system follows the prototyping model described by Presman (2010). This methodology consists of five main stages: communication, quick planning, quick design modeling, prototype construction, and prototype refinement. Below is a detailed explanation of each stage.

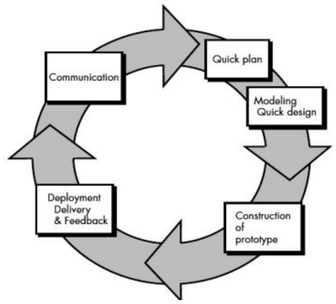

Figure 1.Prototype Model (Pressman: 2010)

2.1 Communication

In the initial stage, the research identified the main problems faced by shrimp farmers, particularly at SMKN 2 Kalianda. These issues included manual feeding, irregular feeding schedules, and inefficiency in feeding methods. Another major concern was the lack of an automatic water temperature monitoring system. Comprehensive communication was conducted with the farmers to define the system requirements for automating the feeding process and real-time temperature monitoring.

2.2 Quick Planning

This stage involved quickly determining the hardware and software requirements for the system. The planned components included the NodeMCU ESP8266 microcontroller, RTC DS3231 for scheduling feed times, a servo motor for feed dispensing, a DS18B20 sensor to measure water temperature, and an LCD I2C 16x2 display for showing temperature data. Additionally, a backup battery and energy controller were included to ensure the system operates during power outages. The system's data communication was designed to use HTTP protocols for transferring temperature data to a web-based application.

2.3 Quick Design Modeling

The design modeling phase produced an initial concept of how the prototype would function. Key outputs included:

- **System Architecture Diagram:**
  Illustrating the relationship between the NodeMCU ESP8266, sensors, actuators, and the IoT server.
- **Web Interface Design:**
  Providing a visualization of how users can monitor pond temperature and feeding schedules through the web application.
- **System Flowchart:**
  Outlining the process flow, including temperature measurement, feeding schedule management, and hardware control.

2.4 Prototype Construction

In this phase, the prototype was developed based on the initial design. The constructed prototype included:

- **Hardware:**
  NodeMCU ESP8266 integrated with the DS18B20 sensor, servo motor, RTC DS3231, and LCD I2C 16x2. Additionally, an energy control system was implemented to manage power distribution between the main power source and the backup battery.
- **Software:**
  Programs developed using Arduino IDE for hardware control and a web-based IoT application that uses HTTP protocols to receive and display temperature data and feeding schedules in real-time.

2.5 Prototype Refinement

After completing the initial prototype, functionality evaluations were conducted with shrimp farmers. Feedback gathered during this stage was used to refine the prototype to better meet user needs. Tests were carried out to ensure the system dispensed feed according to the predefined schedule and quantity, displayed accurate temperature data, and allowed real-time monitoring via the web application. After refinements, the final prototype was tested in the shrimp pond environment to assess its efficiency compared to traditional manual feeding methods.

3. Result and Discussion

The prototype of the IoT-based automatic shrimp feeding system was installed at the edge of the shrimp pond at SMKN 2 Kalianda, located at Jl. Soekarno-Hatta Km No.52, Kedaton, Kalianda Sub-district, South Lampung Regency. Mrs. Yuni Haryati, S.TP., the Head of the Fisheries Department at SMKN 2 Kalianda, served as a key resource person for the implementation. The installation aimed to test the prototype's performance in real field conditions, replicating the environment it would face during practical application. This process was expected to provide valuable insights for the further development of the system, enhancing its functionality and effectiveness as an automatic shrimp feeding tool.

The prototype testing at SMKN 2 Kalianda shrimp ponds was successfully implemented. The testing was conducted in the afternoon at 15:30. During the test, the power source successfully supplied electricity to all components, allowing the ESP8266 microcontroller to process inputs from the RTC and DS18B20 temperature sensor. Consequently, the LCD displayed the day, time, and current water temperature. The ESP8266 microcontroller also delivered outputs to the servo motor and relay. The feeding mechanism was activated when the LCD displayed the pre-set feeding time. At this point, the servo motor opened the shrimp feed valve, and the relay powered the dynamo, ensuring the shrimp feed was evenly distributed throughout the pond. This field test confirmed the functionality and reliability of the prototype under actual conditions, providing a strong foundation for further improvements and development of the system.

Figure 2. Tool Testing

In the feeding process, the ejection dynamo throws the shrimp feed with varying distances. The farthest distance that can be achieved is up to 1.5 meters, while the closest distance is less than 10 cm. With this capability, shrimp feed can be distributed evenly and systematically throughout the pond.

Number	Time	Throwing	Distance (Meter)	Near (Meter)
1	15.00	√	1,5	0,2
2	19.00	√	1,5	0,2

In addition, the use of batteries was also successfully implemented in this system. The battery is able to provide enough power to run all components, including the microcontroller, lcd, sensors, servo, and dynamo motor components, including microcontroller, LCD, sensor, servo, and dynamo motor, so that the system becomes more efficient because when the pln's power is off the battery will automatically become the replacement power automatically become a replacement power.

4. Conclusions

The testing of the automatic shrimp feeding system at the shrimp farm of SMKN 2 Kalianda was successfully conducted. The system demonstrated its ability to connect to the internet via WiFi, allowing the microcontroller to retrieve time data from the server and synchronize it with the RTC (Real-Time Clock). Once the server and RTC times were aligned, the DS18B20 sensor successfully detected the water temperature in the shrimp pond.

The system performed well in feed distribution, with the feed ejection distance reaching up to 1 meter for the farthest point. The LCD display provided real-time information on the current time and system status, enabling users to monitor and operate the device with ease. This automated feeding system significantly reduced the reliance on manual labor, improved efficiency in feed management, and minimized the risk of human error, offering a promising solution for modern shrimp farming practices.

To further enhance the capabilities of the IoT-based shrimp feeding system, advanced features such as integration with data analytics and machine learning-based control systems could be introduced. These technologies can improve the system's ability to predict feeding needs and automate adjustments more effectively. For instance, if the water temperature deviates from the optimal range, the system could send notifications to users, providing recommendations on the exact amount of saltwater that should be added to the shrimp pond. This feature would ensure optimal water conditions are maintained, contributing to the health and productivity of the shrimp. Such advancements would not only enhance system functionality but also improve efficiency and reduce manual intervention in shrimp farming operations.

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