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THE 13TH INTERNATIONAL INNOVATION, INVENTION & DESIGN COMPETITION 2024

EXTENDED ABSTRACTS

e-BOOK

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AUTOMATIC SHRIMP SEED COUNTING DEVICE BASED ON INTERNET OF THINGS (IOT) AND ARTIFICIAL INTELLIGENCE (AI) TO SUPPORT PRECISION SUSTAINABLE FARMING

Hanas Muchamad Hanis[1], Hamim Hasan Muslim[2], Ronal Reigen[3],
Elvira Sukma Wahyuni[4] and *Firdaus[5]

[1,2,3,4,5]Universitas Islam Indonesia, Jalan Kaliurang Km 14,5 Yogyakarta Indonesia

*firdaus@uii.ac.id

ABSTRACT

Indonesia, as a maritime country with significant fishery product exports, recorded an export value of 5.72 billion USD, with shrimp being the main commodity. Despite the global recognition of its fisheries industry, particularly shrimp farming, there are still serious issues such as disease outbreaks causing substantial losses. The problem arises from the incongruity between pond size and the quantity of shrimp larvae released. This leads to serious issues in the shrimp growth process because the density of shrimp in a pond affects the amount of feed given and the growth of the shrimp. Inappropriate shrimp density results in suboptimal growth. Current field solutions are still conducted manually, leading to inefficiencies and human error. Considering the vast potential of shrimp farming and the various existing problems, technological approaches, including automation in shrimp seed counting, need to be developed to improve farming outcomes. This research aims to enhance the quality and efficiency of shrimp farming through automation technology, reduce human error, and increase observation accuracy, all of which are expected to boost both the quantity and quality of shrimp harvests. The resulting prototype can perform automatic counting with an accuracy rate of 96.2% within 5 minutes per bag. Monitoring crucial parameters in seed dispersal, such as temperature and salinity, can be carried out by applying IoT through the Blynk application.

Keyword: Shrimp Farming, Image Processing, IoT

1. INTRODUCTION

Indonesia is known as a maritime country and is one of the world's largest exporters of fishery products, with fishery export values reaching 5.72 billion USD. The main commodity is shrimp, which accounts for up to 40% of export commodities [1]. Indonesian fishery commodities are recognized for their superior quality, leading to high demand in foreign markets. The sustainability of shrimp farming is highly influenced by the quality and continuous availability of shrimp larvae, ensuring optimal farming operations [2]. Currently, the process of counting shrimp larvae in the hatchery sector is still conducted manually using sampling methods with subjective calculations [3]. Errors in counting results can lead to prolonged negative effects, particularly in the failure of shrimp farming planning. The size of the ponds and the number of larvae released into them are crucial at the beginning of shrimp farming because the density of shrimp in a pond affects the amount of feed provided and the shrimp's growth. Inappropriate shrimp density results in suboptimal growth [4]. This condition is related to the feeding competition within the shrimp pond and issues regarding carrying capacity or the pond system's ability to support shrimp activity. To date, the sale of shrimp larvae, both in hatcheries and grow-out farms, still uses manual counting methods, which are inefficient in terms of time and labor and have low accuracy levels. Therefore, considering the vast potential of shrimp farming and the existing problems within the industry, technological approaches need to be developed to maximize results.

2. METHODOLOGY

2.1 Design Specifications

The design of the shrimp larvae counting system will consider the following aspects:

a) Real-Time Counting System
The counting system will operate in real time and be monitored by the user. This ensures that the counting process is immediate and accurate, reflecting the actual condition of the larvae based on the obtained readings.

b) Utilization of Multiple Sensors
   i. Temperature Monitoring with LM35 Sensor: The LM35 sensor will be used to monitor the temperature of the shrimp larvae within the shipping bags. Maintaining the right temperature is crucial for the health and viability of the larvae.
   ii. Salinity Monitoring with TDS Meter: A TDS (Total Dissolved Solids) meter will be employed to measure the salinity of the water in the shipping bags. This ensures that the water conditions are suitable for the larvae, allowing farmers to adjust the pond conditions accordingly.
   iii. By monitoring both temperature and salinity for each bag of shrimp larvae, the system provides comprehensive oversight to ensure optimal conditions for the larvae.

c) IoT-Enabled Monitoring and Control
The system will integrate IoT (Internet of Things) technology using the Blynk application. This includes:
   i. Temperature Readings: Monitoring the temperature of the shrimp larvae in real-time.
   ii. Salinity Readings: Monitoring the salinity levels in the shipping bags.
   iii. Activation of the Shrimp Larvae Counting System: Users can control and monitor the counting process remotely via the Blynk app.

2.2 System Design

The designed system refers to Figure 1, which shows a detailed complete image of the device: (1) shrimp larvae holding container, (2) servo 1, (3) shrimp larvae image capture container, (4) action camera, (5) 10-watt LED bulb, (6) switch, (7) socket outlet, (8) adapter, (9) DS18B20 sensor, (10) TDS meter, (11) ESP32, (12) servo 2, and (13) shrimp larvae output channel. In the initial condition, servo 1 and servo 2 will be switched off or closed. The user turns on the switch to open servo 1, allowing the shrimp larvae to flow from the filling container to the holding container (counting area). When the shrimp larvae are in the holding container (counting area), the action camera captures images of the larvae. At this stage, an image processing-based detection and counting system is applied. Next, the system operates according to the programmed conditions, changing servo 1 to the close position and servo 2 to the open position. This action directs the shrimp larvae from the holding container to the output channel after the counting process. The mechanical system is equipped with a buzzer to provide information for each condition change in the valves.

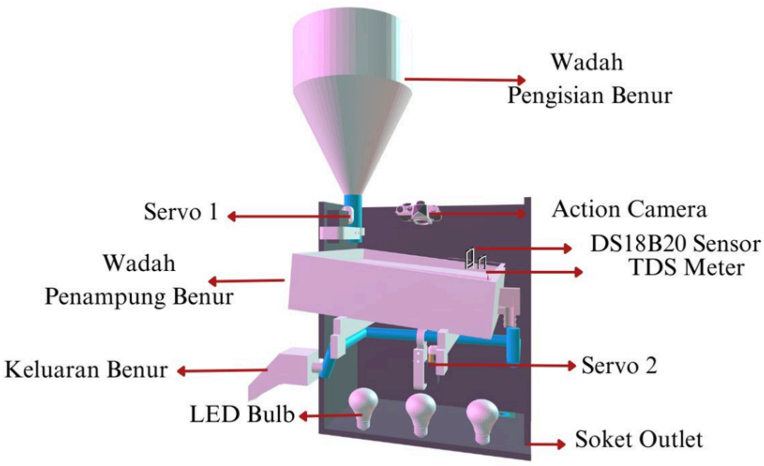

Figure 1 System Design

3. FINDINGS

The training results for the shrimp larvae counting system achieved a rate of 98%, with detection accuracy at 97.31% and counting accuracy at 98%. The average testing result was 96.2%. The tests showed that the system could effectively detect and count the larvae. However, several parameters affected the system's counting performance. Issues such as overlapping shrimp larvae and murky water impacted the system's ability to detect the larvae, causing some larvae in these conditions to be overlooked during counting. This issue can be minimized by tilting the holding container, allowing the larvae to move in the direction of the water flow. Furthermore, electrical protection was added with an acrylic box to shield the electrical system from water splashes during the counting process. This protective system is designed to safeguard the electrical components, including the lamp and the ESP32 microcontroller control instruments. From the DS18B20 sensor readings, the RMSE (Root Mean Square Error) value obtained was 0.25. The TDS meter sensor readings showed an RMSE value of 0.5, as illustrated in Figures 2 and 3.

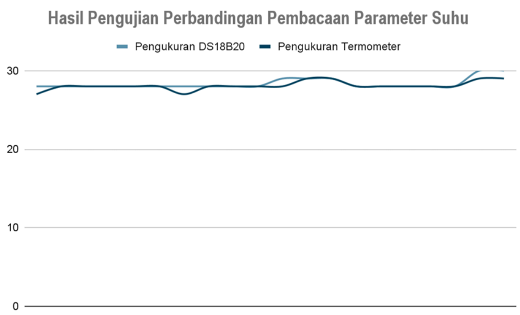

Figure 2 Graph of the Comparison Test Results of Temperature Parameter Readings between LM35 Sensor and Thermometer.

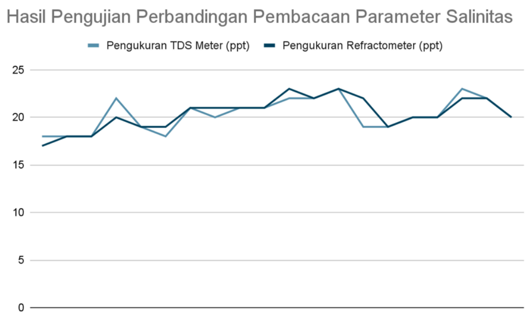

Figure 3 Graph of Testing Results Comparing Salinity Parameter Readings between TDS Sensor and Refractometer

4. CONCLUSION

Based on the analysis of a series of tests conducted on the Artificial Intelligence-based Shrimp Larvae Counting Device, several conclusions were drawn as follows:

a) The system design using the You Only Look Once (YOLOv8) method provides accurate and effective counting results, with an accuracy rate of 95% in the model. However, direct counting testing using shrimp larvae in the system has not been conducted yet.
b) Estimation calculations using instrumentation testing with 4 liters of water require approximately 2 minutes, significantly faster than manual sampling methods, which typically take 2 hours.
c) The implemented image processing method indicates that higher-resolution image captures result in better algorithmic program outcomes.

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