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Design and Development of a Microcontroller-Based Catfish Fry Counter

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Abstract

Catfish farming in Indonesia has great potential, but conventional seed counting methods still face time constraints and a high risk of error. This study aims to design an automatic catfish seed counter based on the Arduino Mega 2560 microcontroller, integrated with an E18-D80NK infrared distance sensor and a DS18B20 temperature sensor. This tool is specifically designed for fry measuring 6–8 cm, with the infrared sensor detecting the number of fry passing through the path, while the DS18B20 sensor monitors the water temperature in the holding tank. The operational process includes inputting the target number via a 4x4 keypad, opening the counting path using a servo motor, measuring the water temperature, and displaying the data on a 16x2 LCD before the path is closed again. Test results show that the DS18B20 sensor has an accuracy of 97.68% (error 2.32%), while the infrared sensor has an accuracy of 89.08% (error 10.92%). This device successfully counts seeds automatically, monitors water temperature, and displays information in real-time. Thus, this Arduino Mega 2560-based catfish seed counter is expected to improve time and labor efficiency, as well as minimize errors in the catfish seed counting and distribution process.

Keywords: Catfish Fry, Microcontroller, Arduino Mega 2560, E18-D80NK Infrared Proximity Sensor, DS18B20 Sensor, Automatic Counter.

Abstrak

Budidaya lele di Indonesia memiliki potensi besar, namun metode penghitungan benih konvensional masih menghadapi kendala waktu dan risiko kesalahan tinggi. Penelitian ini bertujuan merancang alat penghitung otomatis benih lele berbasis mikrokontroler Arduino Mega 2560, yang terintegrasi dengan sensor jarak inframerah E18-D80NK dan sensor suhu DS18B20. Alat ini dirancang khusus untuk benih berukuran 6–8 cm, dengan sensor inframerah mendeteksi jumlah benih yang melewati jalur, sementara sensor DS18B20 memantau suhu air pada bak penampungan. Proses operasional meliputi input jumlah target via keypad 4x4, pembukaan jalur penghitungan menggunakan servo motor, pengukuran suhu air, serta tampilan data pada LCD 16x2 sebelum jalur ditutup kembali. Hasil pengujian menunjukkan akurasi sensor DS18B20 mencapai 97,68% (error 2,32%), sementara sensor inframerah memiliki akurasi 89,08% (error 10,92%). Alat ini berhasil menghitung benih secara otomatis, memantau suhu air, dan menampilkan informasi secara real-time. Dengan demikian, alat penghitung benih lele berbasis Arduino Mega 2560 ini diharapkan dapat meningkatkan efisiensi waktu dan tenaga kerja, serta meminimalisir kesalahan dalam proses penghitungan dan distribusi benih lele.

Kata Kunci: Bibit Ikan Lele, Arduino Mega 2560, Sensor Infrared Proximity E18-D80NK, Sensor DS18B20, Penghitung Otomatis.

1. Introduction

Catfish farming is one of the aquaculture sectors with significant potential in Indonesia. Catfish offers several advantages, including relatively simple cultivation techniques, a short harvest period, and stable market demand. With the growing interest in catfish cultivation, the demand for high-quality catfish fingerlings is also increasing. These fingerlings are essential not only for farmers seeking to expand their aquaculture businesses but also for the grow-out phase until the fish reach market size **[1].**

Despite this demand, the distribution of catfish fingerlings is still counted manually. Such a conventional method is time-consuming and prone to errors due to the limitations of human accuracy in counting individual fish.Previous studies have attempted to develop automatic fish counting systems. One study utilized the E18-D80NK sensor to detect passing fish; however, the device lacked manual control and did not provide a real-time display interface for users **[2].** Another study employed optical sensors, but their performance was strongly influenced by lighting conditions and showed limited accuracy in detecting fast-moving fish **[3].**

These limitations indicate the need for a more accurate and environmentally adaptive system. One promising solution is the use of infrared proximity sensors, which detect fish by interrupting infrared light between an emitter and a receiver. When a fish passes through the sensor's path, its body blocks the infrared beam, and the system registers it as a single passing object. This mechanism has been proven to be more reliable for fish counting compared to other sensor-based systems **[4].** Apart from counting accuracy, environmental factors such as water temperature also play a critical role in ensuring the survival and quality of catfish fingerlings. Unsuitable water temperatures can disrupt fish metabolism, reduce fingerling quality, and increase mortality rates. Therefore, real-time water temperature monitoring is an essential aspect of fingerling distribution **[5].**

Most previous studies have focused solely on fish counting systems, without considering environmental parameters that directly influence fingerling quality. This highlights the need for an integrated system that not only automates the counting process but also monitors water temperature to maintain fingerling viability during distribution.

2. Method

Research methods are systematic, measurable, and objective scientific procedures designed to obtain valid and accountable data. This study employed an experimental method with a quantitative approach, in which the device was designed, constructed, and tested directly, while numerical data were collected for analysis **[6] [7].** This method was chosen because the focus of the study lies in the practical application of developing a catfish fingerling counting device based on a microcontroller, enabling the effectiveness, speed, accuracy, and reliability of the device to be directly observed and quantitatively measured **[8] [9].**

The research stages consisted of system design, device construction and implementation, testing, and data analysis. The system design involved developing the hardware configuration, which included the Arduino Mega 2560 microcontroller, the DS18B20 sensor for measuring water temperature, the E18-D80NK infrared proximity sensor for fingerling counting, and other supporting components such as a servo motor, 16x2 LCD, and 4x4 keypad.

The software design was carried out using the Arduino IDE to ensure all components operated in an integrated manne **[10]**. Device construction and implementation were conducted by assembling all components according to the design and programming the microcontroller to enable automatic system operation. Testing was performed to evaluate the performance of each sensor as well as the system as a whole, by comparing the device's counting results with manual counting. Data analysis was carried out using a descriptive quantitative method with the following formula:

$$\boldsymbol{Error}\ (\%) = \left|\frac{\boldsymbol{Nilai\ sensor - Nilai\ Aktual}}{\boldsymbol{Nilai\ Aktual}}\right|\ \boldsymbol{x}\ \mathbf{100\%}$$

By applying this experimental quantitative method, the study is expected to produce accurate data regarding the performance of the catfish fingerling counting device, in terms of speed, accuracy, and reliability. Furthermore, it provides a solid foundation for evaluation and future development.

2.1 Device Planning

The design of the catfish fingerling counting device is the implementation of the quantitative experimental method. Device planning was carried out by determining the component specifications, selecting the sensors and actuators to be used, and designing the overall workflow of the system. The application of the experimental method allows direct observation of the device's effectiveness, speed, accuracy, and reliability, so that the collected data can be quantitatively analyzed.

The planning stage began by defining the main functions of the system, namely to automatically count the number of catfish fingerlings and to monitor the water temperature in the holding tank. Component selection was adjusted to meet the technical specifications and system requirements. The main components include the Arduino Mega 2560 microcontroller as the control unit, the DS18B20 sensor for monitoring water temperature, the E18-D80NK infrared proximity sensor for counting catfish fingerlings, a servo motor as the actuator, a 16x2 LCD for displaying the counting results, and a 4x4 keypad as the user input interface. The planning stage also involved the mechanical design of the holding tank and the counting channel to ensure smooth operation and optimal system performance.

2.2 System Block Diagram

The block diagram of the catfish fingerling counting device illustrates the overall workflow of the system, from input to processing and output. The system input is obtained from two main sensors: the DS18B20 sensor for monitoring water temperature and the E18-D80NK infrared proximity sensor for counting the number of catfish fingerlings. In addition, the 4x4 keypad functions as a user input medium to set the number of catfish fingerlings to be counted and to initiate the counting process.

All data from the sensors and keypad input are processed by the microcontroller, which manages the output in the form of displaying results on the 16x2 LCD and controlling the servo motor to automatically open and close the counting channel for catfish fingerlings. The block diagram of the system design for the "Development of a Catfish Fingerling Counting Device Based on Microcontroller" is presented in the following figure.

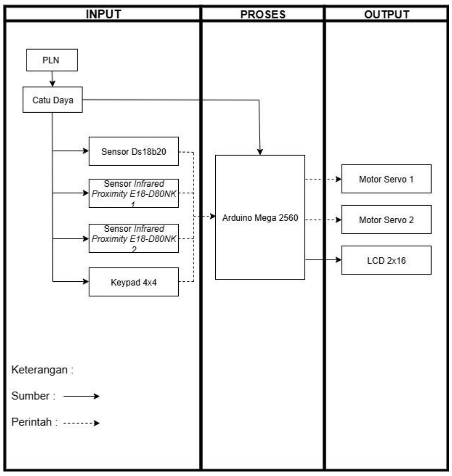

Figure 1. System Block Diagram

2.3 Circuit Schematic

The circuit schematic represents the technical illustration of how all electronic components are interconnected. It serves as a guide in assembling the hardware to ensure that the device operates according to the research objectives.

The schematic facilitates the identification of wiring paths, interconnections between components, and the arrangement of the required current and voltage. With a clear schematic, the processes of assembly, system testing, and hardware–software integration can be carried out in an orderly and systematic manner. The schematic also acts as a reference to ensure that the data flow and control processes within the system function accurately and consistently.

The circuit schematic of the "Design and Development of a Catfish Fingerling Counting Device Based on Microcontroller" is shown in the following figure.

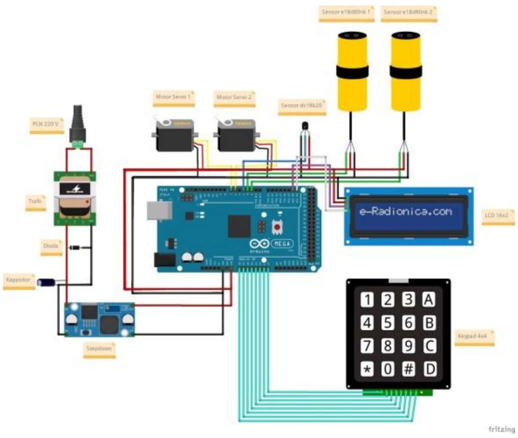

Figure 2. Circuit Schematic

2.4 System Flowchart

The system flowchart is a diagram that illustrates the sequence of operations of the entire system, starting from receiving input to producing output. The flowchart serves as a guide in software design, helping to ensure that each process is executed in a sequential and logical manner. With a well-structured flowchart, software development becomes more organized, hardware integration is simplified, and the device can operate effectively, accurately, and reliably.

The system flowchart of the "Design and Development of a Catfish Fingerling Counting Device Based on Microcontroller" is shown in the following figure.

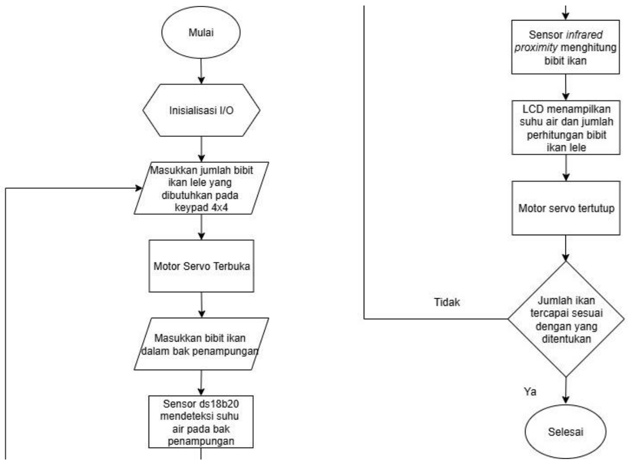

Figure 3. System Flowchart

2.5 Device Operation

The microcontroller-based catfish fingerling counting device is designed to facilitate the counting process by utilizing several electronic components, including the DS18B20 sensor, the E18-D80NK infrared proximity sensor, a servo motor, a 16x2 LCD, and a 4x4 keypad. The detailed operation of the device is as follows:

1. Input of fingerling quantity

   The user enters the desired number of catfish fingerlings through the 4x4 keypad. This input value serves as the reference for the system in carrying out the counting process.

2. Servo motor opens

   After the input is entered, the servo motor opens the counting channel for the fingerlings.

3. Insertio of fingerlings

   The catfish fingerlings are placed into the holding tank to be counted.

4. Water temperature measurement

   The DS18B20 sensor detects the water temperature in the holding tank. This information is necessary to ensure that the water conditions remain within a safe range for the catfish fingerlings.

5. Fish counting

The E18-D80NK infrared proximity sensor counts the number of catfish fingerlings passing through the counting channel.

6. Data display on LCD

   The results of the water temperature measurement from the DS18B20 sensor and the fish count from the infrared proximity sensor are displayed on the 16x2 LCD screen.

7. Servo motor closes

   Once the counting process is complete or the desired number of fish has been reached, the servo motor closes the fingerling input channel.

8. Process completion

   When the fish count matches the specified number, the system ends the process and the device stops operating.

3. Results and Discussion

The performance testing of the equipment was conducted to ensure that all components of the microcontroller-based catfish fingerling counting system operated in accordance with the design. This testing included evaluating the performance of the DS18B20 sensor and the infrared proximity sensor, as well as comparing the sensor detection results with the actual number of catfish fingerlings.

3.1 DS18B20 Sensor Testing

The DS18B20 sensor was used to measure the water temperature in the catfish fingerling holding tank. The testing was carried out by comparing the sensor readings with a digital thermometer as a reference. The purpose of this test was to determine the accuracy and stability of the sensor in measuring water temperature.

Table 1. Results of DS18B20 Sensor Testing

No.	Thermometer Temperature (°C)	DS18B20 Sensor Temperatur e (°C	Difference (°C)	Error (%)	Temperature Description
1.	28.3	29.00	0.70	2.47	Aman
2.	28.5	29.19	0.69	2.42	Aman
3.	28.5	29.19	0.69	2.42	Aman
4.	28.9	29.21	0.31	1.07	Aman
5.	28.9	29.61	0.71	2.46	Aman
6.	28.0	28.71	0.71	2.54	Aman
7.	27.6	28.32	0.72	2.61	Aman
8.	29.6	30.11	0.51	1.72	Aman
9.	28.7	29.43	0.73	2.54	Aman
10.	27.7	28.43	0.73	2.64	Aman
11.	29.2	29.88	0.68	2.33	Aman
12.	28.8	29.56	0.76	2.64	Aman
13.	29.5	30.19	0.69	2.34	Aman
14.	27.7	28.44	0.74	2.67	Aman
15.	29.6	30.16	0.56	1.89	Aman
16.	29.8	30.19	0.39	1.31	Aman
17.	28.1	28.87	0.77	2.74	Aman
18.	29.3	30.02	0.72	2.46	Aman

No.	Thermometer Temperature (°C)	DS18B20 Sensor Temperature (°C	Difference (°C)	Error (%)	Temperature Description
19	27.9	28.66	0.76	2.72	Aman
20.	28.9	29.59	0.69	2.39	Aman
Average				**2.32**	

Based on 20 test trials, the thermometer and DS18B20 sensor readings ranged from 27.6 °C to 30.3 °C. This range is still within the ideal temperature for catfish fingerlings (25 °C – 30 °C). The average error obtained was 2.32%, which is below the tolerance limit of 5%, indicating that the sensor readings are reliable and suitable for water temperature monitoring. Therefore, the accuracy level of the sensor reaches 97.68%.

3.2 Infrared Proximity Sensor Testing

The infrared proximity sensor was used to count the catfish fingerlings passing through the sensor. Testing was conducted 20 times using a total of 200 catfish fingerlings. During the counting process, the number of fingerlings passing through was recorded manually as the actual count, while the system automatically counted the fish detected by the infrared sensor.

Table 2. Results of E18-D80NK Infrared Proximity Sensor Testing

No.	Actual Count (pcs)	Detected Count (pcs)	Difference (pcs)	*Error* (%)
1.	10	7	3	30.00
2.	20	11	9	45.00
3.	30	25	5	16.67
4.	40	37	3	7.50
5.	50	46	4	8.00
6.	60	55	5	8.33
7.	70	64	6	8.57
8.	80	74	6	7.50
9.	90	83	7	7.78
10.	100	92	8	8.00
11.	110	102	8	7.27
12.	120	111	9	7.50
13.	130	121	9	6.92
14.	140	130	10	7.14
15.	150	140	10	6.67
16.	160	149	11	6.88
17.	170	158	12	7.06
18.	180	167	13	7.22
19.	190	176	14	7.37
20.	200	186	14	7..00
Average				**10.92**

Based on the test results, the number of catfish fingerlings detected by the sensor showed some differences compared to the actual number of fingerlings. These differences resulted in varying error percentages across the trials, with an average error of 10.92%. The results indicate that the catfish fingerling counting system has functioned optimally, although further design improvements are needed to reduce the error rate. Consequently, the sensor's accuracy reaches 89.08%.

4. Conclusion

The Arduino Mega 2560-based catfish fingerling counting device was successfully developed and operates according to the design, automatically counting the number of catfish fingerlings using the E18-D80NK infrared proximity sensor while monitoring the water temperature in the holding tank.

The DS18B20 sensor testing results indicated an accuracy of 97.68% with an average error of 2.32%, demonstrating that the sensor is suitable for measuring the water temperature of catfish fingerlings in the holding tank.

The infrared proximity sensor testing results showed an accuracy of 89.08% with an average error of 10.92%. The sensor functions optimally in counting the number of fingerlings, although discrepancies may occur due to the speed of fish movement.

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