Design of A Catfish Seed Sorting Machine with Calculation of Quantity and Selling Price

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***Abstract*— This research addresses the inefficiencies in manual catfish sorting and sales data management encountered by small-scale farmers. The study designs and implements an automated sorting machine integrated with a quantity counting and sales price calculation system. The machine employs a three-tiered aluminum sieve mechanism to sort catfish by size (large, medium, small). An automated counting system utilizing a photodiode sensor and KY-008 laser module tallies the fish in each category. System data is displayed locally on a 16x2 LCD and transmitted remotely to an Android smartphone application. The application allows users to set selling prices and log sales transactions, with data automatically synced to a Google Spreadsheet for record-keeping. Testing results demonstrated the system's functionality: a sorting trial yielded counts of 1 large, 14 medium, and 3 small catfish (total 18), while a sales simulation correctly counted 1 large, 5 medium, and 2 small fish. The "SAVE" and "SELL" buttons in the application successfully triggered data storage and automated price calculations in the spreadsheet. The integrated system provides a practical solution to automate sorting, counting, and sales documentation, thereby improving operational efficiency and accuracy for catfish farmers.**

Keywords: Catfish Sorting Machine, Automated Counting, Photodiode Sensor, Android Application, Sales Data Management, Smart Aquaculture

I. INTRODUCTION

Catfish farming is one of the leading commodities in the aquaculture sector which has high economic value. However, traditional farmers often face significant challenges in the post-harvest process, particularly in sorting (grading) and counting the fish. Previous research highlights that the development of automatic grading machines is essential to increase harvesting efficiency and maintain fish quality compared to manual methods, which are often inconsistent and physically demanding [1]. Comparative analyses indicate that automatic grading significantly outperforms manual methods in terms of time efficiency and labor reduction [2]. To support this mechanical process, the design of conveyor systems based on weight and dimensions plays a vital role in ensuring smooth operations [3].

In modern aquaculture, the integration of technology such as the Internet of Things (IoT) has become a major trend to improve productivity and monitor environmental conditions automatically [4]. The adoption of smart farming technologies has been reviewed in recent studies, showing a positive trend towards full automation in various fishery sectors [5]. This shift towards Industry 4.0 involves transforming traditional aquaculture with Cyber-Physical Systems to create a more integrated ecosystem [6]. Low-cost IoT systems have proven effective in making this technology accessible to small-scale farmers with limited capital [7].

A specific problem that often arises during the harvest period is the inaccuracy of fish counting. Manual counting is prone to human error, leading to financial losses for farmers. Therefore, the implementation of a microcontroller-based automatic counting system using sensors is urgently needed to ensure data accuracy [8]. Specifically, the use of microcontrollers in automating feeding and sorting processes has demonstrated significant improvements in operational precision [9]. To support accurate counting, the application of photodiode and laser sensors is preferred in high-speed object counting systems due to their fast response time [10]. Furthermore, recent evaluations of infrared sensors on conveyor belts confirm their high accuracy for object detection in dynamic environments [11]. Regarding the hardware, studies comparing microcontrollers show that modules like the ESP8266 offer a reliable and cost-effective solution for wireless sensor networks [12], provided that energy-efficient data transmission strategies are applied [13].

Technological advancements also allow for real-time monitoring through smartphones. By using communication protocols such as MQTT, data obtained from sensors can be sent directly to the user's Android device with low latency [14]. For data storage, real-time database implementations using platforms like Firebase allow for seamless synchronization between hardware and mobile applications [15]. For immediate alerts, real-time notification systems using platforms like Telegram Bots have proven effective in keeping farmers updated on harvest status [16]. However, the success of these technologies depends on the User Interface (UI) design; mobile applications must be user-friendly to ensure usability for farmers who may not be tech-savvy [17].

Beyond technical aspects, the economic impact is crucial. The integration of sensors and mobile applications facilitates yield estimation, enabling farmers to predict profits more

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accurately [18]. Digitalization of sales data management is also vital, as it helps farmers calculate total sales and manage transaction history neatly, replacing manual recording books that are vulnerable to loss [19]. From an economic perspective, the impact of digital recording on small-scale fishery businesses has been shown to increase profitability by reducing administrative errors [20]. Techno-economic analyses in Indonesia specifically suggest that IoT implementation in small-scale fisheries is feasible and profitable in the long run [21].

II. METHOD

A. System Diagram Block

This section discusses the tool design process, which includes a block diagram that explains the relationship between components.

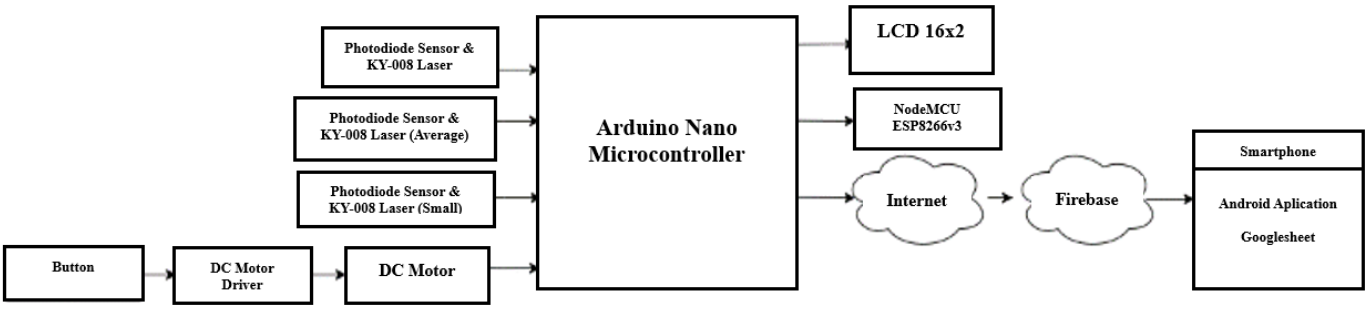

Figure 1. Block diagram of sorting and calculation system

Block diagram of the sorting and arithmetic system, where there are 2 microcontrollers at the center of all the functions performed. The Arduino nano microcontroller acts as the power for the sorting and calculation. The sorting system uses only a DC motor to drive the sorting board and can be adjusted for sorting speed using a DC motor driver. Meanwhile, the nodeMCU 8266 microcontroller acts only as a data transmitter, receiving data from the Arduino nano and sending it to the Firebase database for real-time storage. Photodiode sensor and KY-008 laser as a counter for the number of catfish in stock. Once Firebase has received the latest data, the Android application retrieves the data from Firebase and displays it in the application to monitor the sorting and sales that have been made. Google Sheet is useful here as a container for the data stored by the Android application.

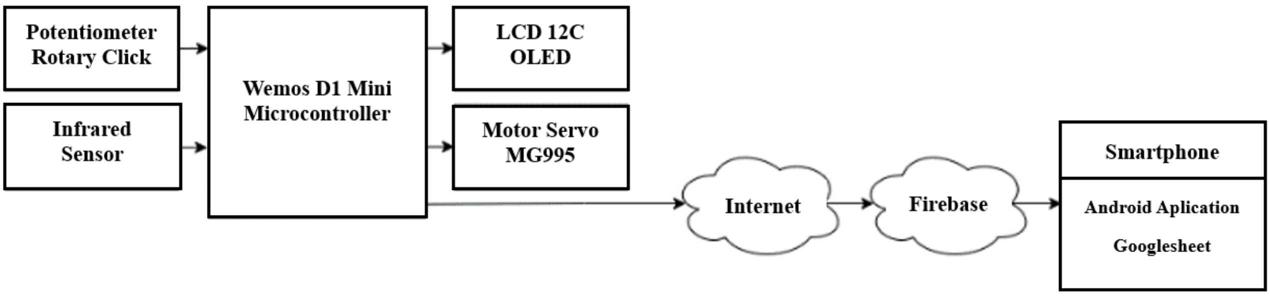

Figure 2. Block diagram of sales system

In Fig. 2 is a block diagram of the sales system where there is a Wemos D1 mini microcontroller as the brain of the system used. There is a rotary click potentiometer as an option selector displayed on the I2C Oled LCD. The infrared sensor is used as a counter for the number of inputs that have been entered on the rotary click potentiometer. The servo motor functions as an opening and closing valve when the number of catfish sales that have been entered is in accordance with what is obtained from the sensor.

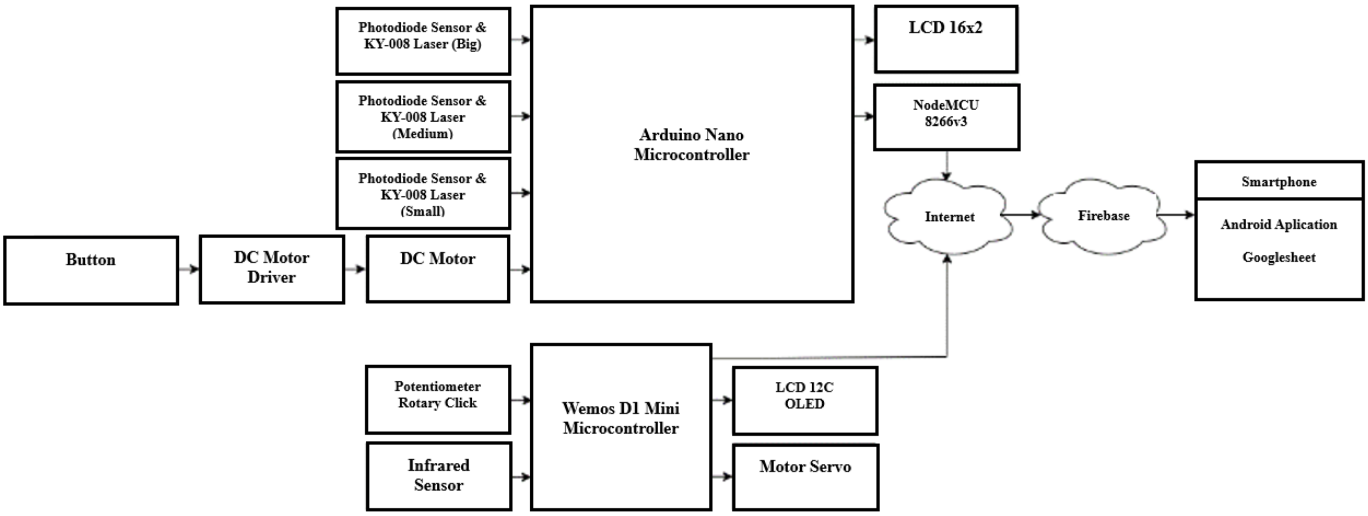

Figure 3. Overall system block diagram

The block diagram of the system in Fig. 3 consists of Arduino Nano microcontroller, on/off button, DC motor, KY-008 photodiode and laser sensor, 16x2 LCD, NodeMCU8266, Wemos D1 Mini, infrared sensor, servo motor, rotary click potentiometer, OLED I2C Oled, Firebase real-time database, Android application and Google Sheet. Arduino Nano as the microcontroller that will give commands to the DC motor to move the sorting board via the on/off button.

Arduino Nano also gives commands to the KY-008 photodiode and laser sensor to read each catfish that passes through. The data received from the sensor is processed by the Arduino Nano, displayed on the 16x2 LCD and sent to the NodeMCU8266. The NodeMCU 8266 will then send the data to Firebase as database storage in real time.

The Android application will retrieve and read data from Firebase and store it after the sorting stage is completed. Once the sorting stage is complete, the next stage will begin, where the OLED screen will display several options as input data for the number of catfish the seller wants to buy through a rotary potentiometer click.

Wemos D1 mini as a microcontroller will give orders to the infrared sensor to read the catfish data that passes through it. Wemos D1 mini will also give commands to the servo motor to open the valve when the count is done, when the number of catfish matches the amount that has been entered, then the servo motor will close the valve. The data is sent to Firebase and passed on to the Android application and finally stored in Google Sheets.

Fig. 4 is a system block diagram in the process of calculating the number of catfish passing through the sensor. The initial sensor reads count = 0 because it receives light from the KY-008 laser where the value received by the photodiode sensor is greater than 850. If there is an object passing through the laser light, the photodiode will get a value less than 850 and the sensor will send count = 1.

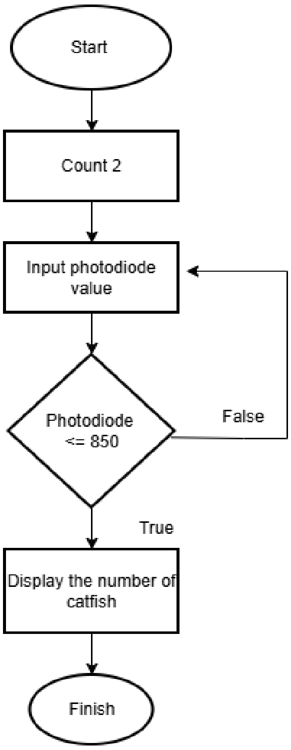

Figure 4. Catfish counter system diagram

B. System Flowchart

The system flowchart in this study has 2 system flowcharts, namely the sorting and calculating system flowchart and the selling system flowchart to consumers. Based on the system flowchart that has been made, it will become 1 flowchart, namely the overall flowchart.

In Fig. 5, the flowchart of the sorting and calculation system can be explained as follows:

- Sorting is carried out by pressing the on/off button on the tool.

- After pressing the button, the machine will move to sort the catfish. Insert the object (catfish) into the sorting machine.
- Then wait for the sorting to finish.
- If the sorting is finished, the sensor will count the number of catfish that have been sorted, but if it is not finished, then wait for all the sorted catfish to be sorted.
- After the sensor has calculated the number of catfish, it will send the data to the Arduino Nano and forward it to the NodeMCU to be sent to Firebase.
- The LCD will display the sorting results obtained by the sensor through the Arduino Nano.

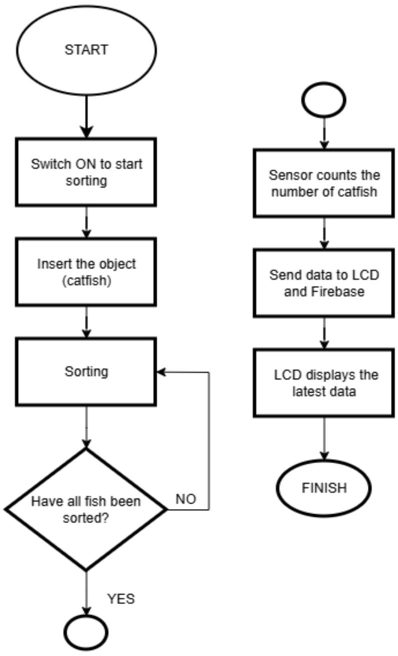

Figure 5. Flowchart of sorting and calculation system

In Fig. 6, the flowchart of the sales system to consumers can be explained as follows:

- When consumers want to buy catfish, they first need to know the size of catfish they want. For example, consumers want a large size catfish with a total of 20 heads. They then select the large size option on the LCD screen.
- Enter the number 20 by turning the potentiometer knob.
- Then select the status option by turning the potentiometer 1x clockwise to perform the sales calculation.
- The servomotor will automatically open according to the size selected.
- Place the catfish in the prepared container.
- The sensor will count the catfish according to the needs of the consumer.
- If the amounts of catfish are not adequate, the valve will not close.
- And when the amounts of catfish are appropriate, the servomotor will automatically close the valve. The sensor will send its data to the LCD and Firebase for monitoring.

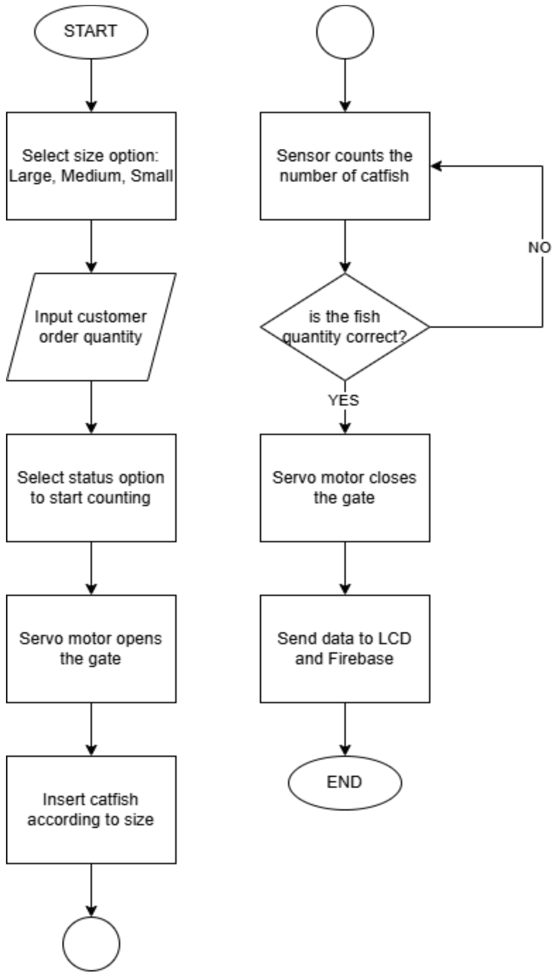

Figure 6 Sales System Flowchart

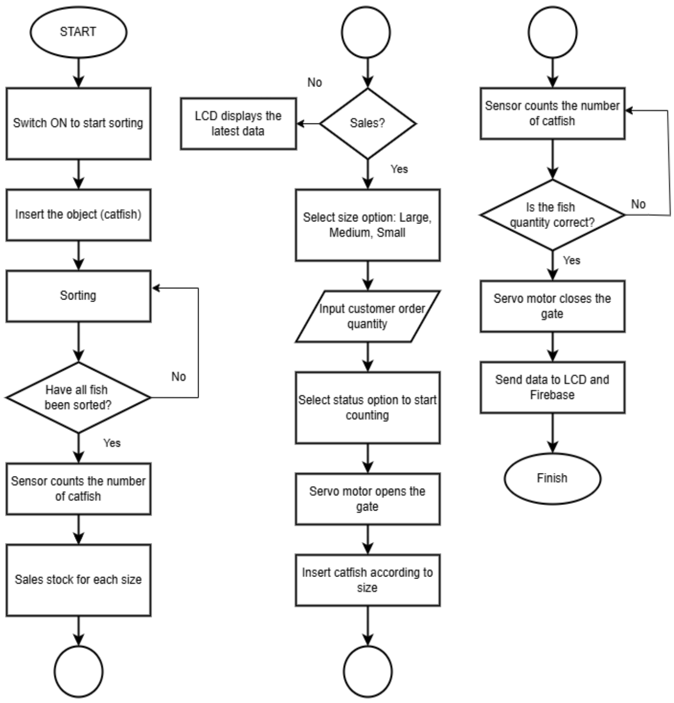

Figure 7. Overall system flowchart

Fig. 7 is the overall system flowchart created from the sorting and calculation system flowchart and the sales system flowchart.

C. Sorting Tool Design

The DC motor will drive the board as a catfish sifter that functions to sort catfish with 3 different sizes. The width of the board gap has a different size. The top board has a larger gap width compared to the bottom board.

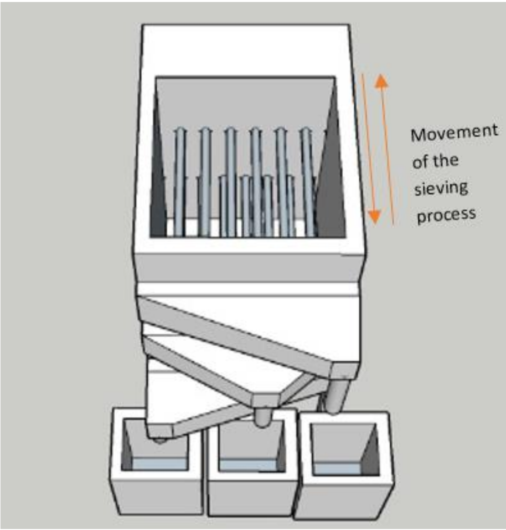

Figure 8. Sorting Tool Design

D. Catfish Counting System

Catfish fry counting uses the characteristics of the photodiode sensor. The calculation process is based on the intensity of the light hitting the sensor. In order to maximize the performance of the sensor, an additional component in the form of KY-008 is used, namely a laser transmitter which functions to shoot light onto the surface of the sensor. The use of the laser aims to make the difference in the light captured by the sensor significant. If there is no object blocking it, the light intensity value read by the sensor will be high; if there is an object blocking it, the light intensity read will decrease.

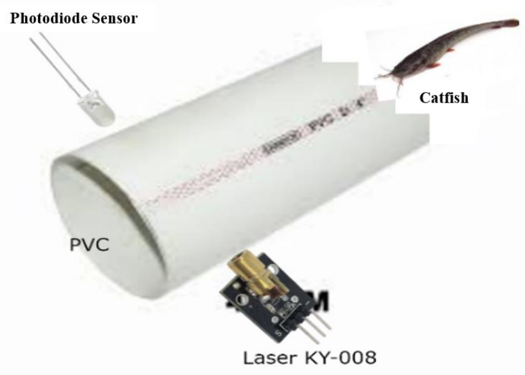

Figure 9. Design of Catfish Counters

The sensor is placed facing the laser in the tube so that the light is directed directly at the sensor (as shown in Fig. 9). Both components are connected to the Arduino Nano microcontroller. In the calculation part, the analysis is done using the appropriate threshold value so that the reading can be done with minimal error. The concern in testing this counting system is the accuracy of the sensor reading results with the actual number of fish. The test is carried out by feeding 18 catfish (samples) into a tube fitted with a photodiode sensor and laser transmitter. The comparison between the actual number of fish and the number read by the sensor is then recorded. From these results it is possible to calculate the error value generated by the designed catfish counting system using the following formula:

$$Error(\%) = \frac{(Difference\ (sorting-counting))}{Real\ catfish} \times 100\% \quad (1)$$

E. Electrical System

The electrical design is the stage that shows how the electronic components work. This stage shows the circuit diagram and how each component works.

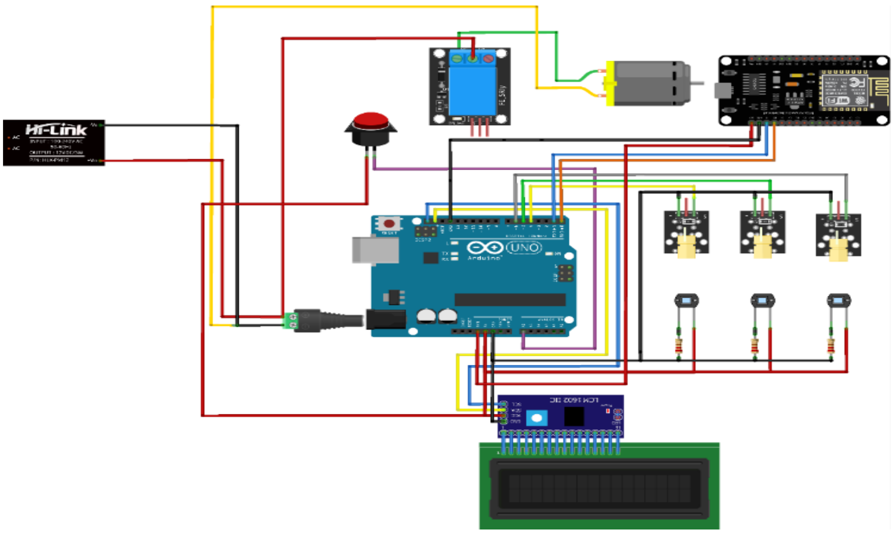

Figure 10. Schematic of catfish sorting circuit

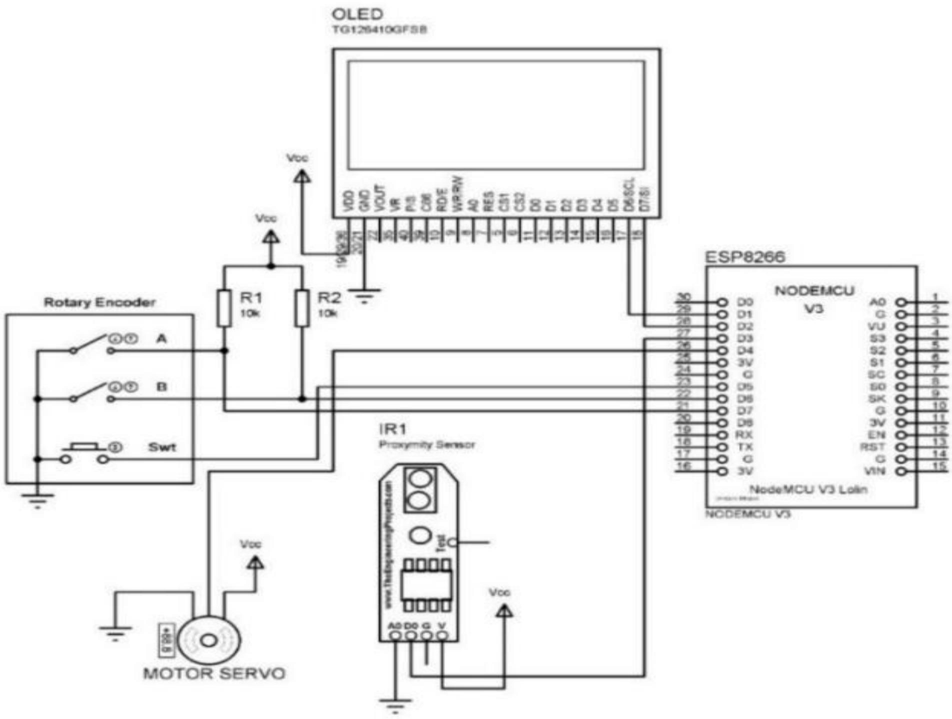

Figure 11. Schematic of catfish counter circuit

III. RESULTS AND DISCUSSION

The overall discussion of the planned results is about testing the sorting tool for consumption catfish with calculation of quantity and selling price. The following are the results of the implementation and analysis of the data obtained.

A. Implementation Results of the Sorting Tool and Sales Quantity and Price Calculator

With the implementation of the tool, a stopper has been manually added to the grading section to optimize the grading process and ensure that the catfish are graded correctly, reducing the errors that occur due to size transitions in each size.

Figure 12. Implementation results of the sorting tool and sales quantity and price calculator from above

Figure 13. Implementation results of the sorting tool and sales quantity and price calculator from the side

B. Testing Results of Catfish Sorting and Counting Tool

The purpose of testing the Catfish Sorting and Counting Machine is to sort catfish of 3 different sizes at the consumption level. After sorting, it will enter the stage of calculating the amount of each size to know the amounts of catfish that has been sorted. The amounts of catfish that has been sorted is used as the stock in the sale.

The purpose of the error calculation performed in Table I is to determine the level of error that occurs in the sensor when calculating the number of catfish in each sensor output. The results of the analysis based on Table I the level of error that occurs is due to the occurrence of catfish outputs that are close together causing the sensor to read 1 catfish passing through it. The results of the error that occurs can be seen in Table I of the 2nd test for medium size.

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TABLE I
TESTING RESULTS OF CATFISH SORTING AND COUNTING TOOL

CATFISH SEEDLING SIZE									
	Large			Medium			Small		
Testing	Machine	Sensor	Error (%)	Machine	Sensor	Error (%)	Machine	Sensor	Error
1	1	1	0	14	14	0	3	3	0
2	1	1	0	14	13	0,07	3	3	0
3	2	2	0	13	13	0	3	3	0
4	1	1	0	14	14	0	3	3	0
5	1	1	0	14	14	0	3	3	0
Average	-		0	-		0,014	-		0

The results of the analysis of the testing of the catfish sorting tools as in Table I there is a difference in the size of the sorted catfish, namely the medium size in the 2nd test. This is because the catfish are close together at the sensor exit, so the sensor reads 1 catfish passing through. In the 3rd test there were 2 large catfish as the catfish were not fully sorted.

The results of the analysis of monitoring tests on LCD 16x2 are in accordance with the data results from table 1 of the test results of the catfish sorting and counting device. There is no error in reading the amount obtained from the LCD 16x2 through the photodiode sensor as a calculation of the number of catfish after sorting.

Figure 14. Sorting monitoring results on 16x2 LCD

C. Testing Results of Catfish Counter in Sales

The purpose of testing the catfish counter at the point of sale is to ensure that the amounts of catfish desired by the consumer is the same as the amount that comes out of the catfish counter system. Where the results of the calculations in sales will be included in the selling price application to determine the selling price.

TABLE II
TESTING RESULTS OF CATFISH COUNTER IN SALES

Testing	Large			Medium			Small		
	Input	Sensor	Error (%)	Input	Sensor	Error (%)	Input	Sensor	Error (%)
1	1	1	0	5	5	0	2	2	0
2	1	1	0	7	6	0,14	3	3	0
3	2	2	0	8	8	0	3	3	0
4	1	1	0	6	6	0	3	3	0
5	1	1	0	10	9	0,1	3	3	0
Average	-		0	-		0,048	-		0

The results of the analysis in Table II show a difference in the results of the 2nd and 5th trials for medium sized catfish. This is influenced by the location of the sensor, which is less stable because it is next to the hole, and the lack of resistance that can cause collisions due to catfish falling past the sensor.

Analysis results from testing monitoring android applications are appropriate and run well with results such as monitoring on 16x2 LCD. There are no differences in results that occur during the process of data income from firebase to the android application that has been made.

D. Sales Price Application Testing Results

The purpose of testing the selling price application is to find out the amount and price of the sales results that have been made.

TABLE III
SALES PRICE APPLICATION TESTING RESULTS

Testing	system	Large		Medium		Small		Total	
		Total	Price (Rp)	Total	Price (Rp)	Total	Price (Rp)	Total	Price (Rp)
1	Sensor	1	-	5	-	2	-	8	-
	Application	1	3.000	5	12.500	2	4.000	8	19.500
2	Sensor	1	-	7	-	3	-	11	-

	Application	1	3.000	7	17.500	3	6.000	11	26.500
3	Sensor	2	-	8	-	3	-	13	-
	Application	2	6.000	8	20.000	3	6.000	13	32.000
4	Sensor	1	-	6	-	3	-	10	-
	Application	1	3.000	6	15.000	3	6.000	10	24.000
5	Sensor	1	-	10	-	3	-	14	-
	Application	1	3.000	10	25.000	3	6.000	14	34.000
Total	Sensor							56	-
	Application							56	136.000

The analysis results in Table III, which test the sales price application to consumers, have no errors sending data to the Google spreadsheet as a data container. The test results are consistent with the final results in the Google Spreadsheet output. The results of the sales log data in the application are also consistent with the log data displayed in the Google spreadsheet.

Figure 15. Sorting monitoring results on android application

Figure 16 Results of monitoring catfish counter in sales on the application

E. Overall System Testing Results

The purpose of testing the whole system that has been built is to find out the results of each test that has been done. The tests that have been carried out are sorting, calculating and also selling. In the sales test, information is given about the total price when the sale is made.

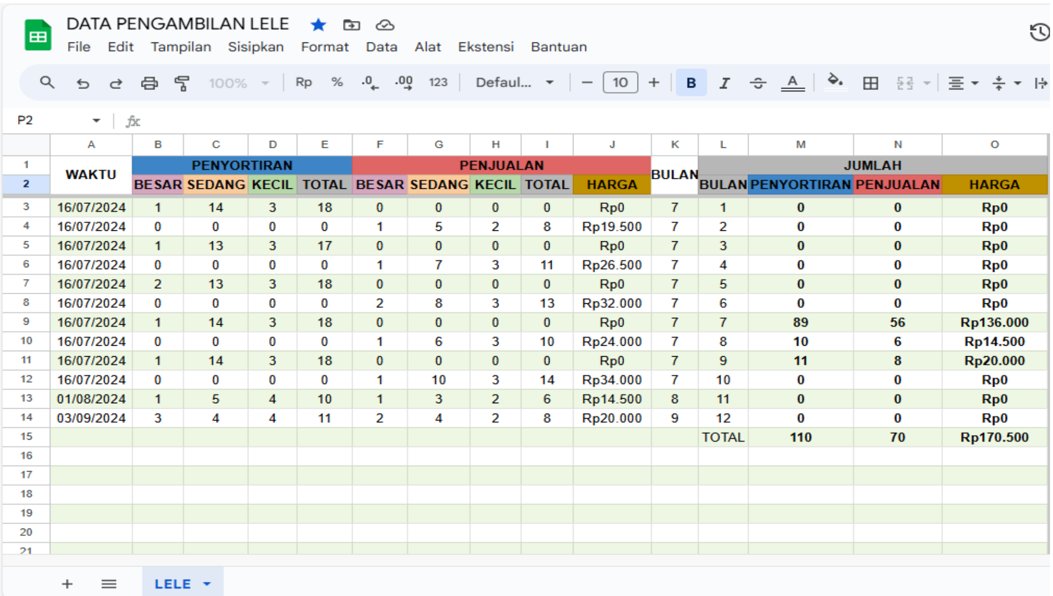
TABLE IV
DATA RESULTS OBTAINED FROM EACH TEST PERFORMED

Testing	System		Catfish seedling size						Total	
			Large	Error (%)	Medium	Error	Small	Error (%)	Total	Price
1	Sort	Machine	1	0	14	0	3	0	18	-
		Sensor	1		14		3		18	-
		LCD	1	0	14	0	3	0	18	-
		Application	1		14		3		18	-
	sell	Sensor	1	0	5	0	2	0	8	19.500
		Application	1		5		2		8	19.500
2	Sort	Machine	1	0	14	0,07	3	0	18	-
		Sensor	1		13		3		17	-
		LCD	1	0	13	0	3	0	17	-
		Application	1		13		3		17	-
	sell	Sensor	1	0	7	0	3	0	11	26.500
		Application	1		7		3		11	26.500
3	Sort	Machine	2	0	13	0	3	0	18	-
		Sensor	2		13		3		18	-

		LCD	2	0	13	0	3	0	18	-
		Application	2		13		3		18	-
	sell	Sensor	2	0	8	0	3	0	13	32.000
		Application	2		8		3		13	32.000
4	Sort	Machine	1	0	14	0	3	0	18	-
		Sensor	1		14		3		18	-
		LCD	1	0	14	0	3	0	18	-
		Application	1		14		3		18	-
	sell	Sensor	1	0	6	0	3	0	10	24.000
		Application	1		6		3		10	24.000
5	Sort	Machine	1	0	14	0	3	0	18	-
		Sensor	1		14		3		18	-
		LCD	1	0	14	0	3	0	18	-
		Application	1		14		3		18	-
	sell	Sensor	1	0	10	0	3	0	14	34.000
		Application	1		10		3		14	34.000
Average		Sort	1,2	0	13,65	0,007	3	0	17,85	-
		Sell	1,2	0	7,2	0	2,8	0	11,2	-

Based on table IV, the whole system test shows all the data results obtained from each test performed.

The data obtained is data from each time you run the experiment. After pressing the 'SAVE' button on the Android application, the data is automatically saved to Google Sheets. For sales data, you need to press the 'SELL' button on the Android application. There is a display of the sorting and sales results for each month.



DATA PENGAMBILAN LELE

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	WAKTU	PENYORTIRAN				PENJUALAN					BULAN	JUMLAH			
2		BESAR	SEDANG	KECIL	TOTAL	BESAR	SEDANG	KECIL	TOTAL	HARGA		BULAN	PENYORTIRAN	PENJUALAN	HARGA
3	16/07/2024	1	14	3	18	0	0	0	0	Rp0	7	1	0	0	Rp0
4	16/07/2024	0	0	0	0	1	5	2	8	Rp19.500	7	2	0	0	Rp0
5	16/07/2024	1	13	3	17	0	0	0	0	Rp0	7	3	0	0	Rp0
6	16/07/2024	0	0	0	0	1	7	3	11	Rp26.500	7	4	0	0	Rp0
7	16/07/2024	2	13	3	18	0	0	0	0	Rp0	7	5	0	0	Rp0
8	16/07/2024	0	0	0	0	2	8	3	13	Rp32.000	7	6	0	0	Rp0
9	16/07/2024	1	14	3	18	0	0	0	0	Rp0	7	7	89	56	Rp136.000
10	16/07/2024	0	0	0	0	1	6	3	10	Rp24.000	7	8	10	6	Rp14.500
11	16/07/2024	1	14	3	18	0	0	0	0	Rp0	7	9	11	8	Rp20.000
12	16/07/2024	0	0	0	0	1	10	3	14	Rp34.000	7	10	0	0	Rp0
13	01/08/2024	1	5	4	10	1	3	2	6	Rp14.500	8	11	0	0	Rp0
14	03/09/2024	3	4	4	11	2	4	2	8	Rp20.000	9	12	0	0	Rp0
15												TOTAL	110	70	Rp170.500

Figure 17. Display results on google sheets

The data can be shared directly via the following link: https://docs.google.com/spreadsheets/d/1GU9eRULXt7gmQykEUWH5BWMcZaNQ9DlXU_vPMxHJ_SM/edit?usp=sharing

IV. CONCLUSION

The developed catfish seed sorting machine successfully categorized catfish according to size with high accuracy. During testing, only one misclassification occurred—specifically, a medium-sized fish was incorrectly placed in the large-size compartment during the third trial. The counting mechanism, which integrates a KY-008 laser and a photodiode sensor, demonstrated reliable performance; however, a minor counting error was observed in the second trial when two fish passed through the sensor simultaneously, causing them to be registered as a single entity. Overall, sensor accuracy remained high, with only two size classification errors recorded across all trials (in trials 2 and 4). User interaction is facilitated via an I2C OLED display, allowing selection of operational modes, while data persistence is enabled through dedicated “SAVE” (for sorting results) and “SELL” (for pricing) buttons in the companion application. Both sorting outcomes and corresponding selling prices are synchronized in real time to the mobile application and a Google Spreadsheet, enabling efficient monitoring and record-keeping for users.

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