An Automatic Waste Cleaning System in Shrimp Ponds with Digital Image Processing using the Internet of Things

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Abstract— **Super intensive shrimp pond wastewater with a stocking density of 750-1,250 individuals/m^2 contains an average total suspended solids (TSS) of 798-924 mg/L, dissolved organic matter (BOT) of 81,227-88,641 mg/L; total nitrogen (TN) 9.8389-14.4260 mg/L; and total phosphate (TP) 7.8770-11.8720 mg/L. This value has exceeded the threshold limit of the permissible pond wastewater standard so it has the potential to hurt the environmental quality of water bodies receiving the waste load. making a more intensive vannamei shrimp farming pond cleaning system using turbidity sensors to read turbidity in shrimp farming ponds and ultrasonic sensors as readers of the water level in shrimp farming ponds and using a camera to detect the presence of foam waste in shrimp farming ponds and the Raspberry Pi microcontroller as a center system control on control devices and monitoring of all sensors then the output data will activate the drainage of leftover shrimp feed and shrimp waste from drainage to disposal using PVC pipes and automatic faucets that are driven using DC power window motors. The Internet of Things (IoT) automatic system in the construction of a waste cleaning device for shrimp ponds was built using a turbidity sensor that can detect the level of turbidity in water with an accuracy of 0.51%. The need for additional water in the pond is assisted by an ultrasonic sensor which provides information to the water pump with an average accuracy of 0.56%. To detect foam waste using a webcam camera as a foam detector.**

***Keywords*— Shrimp ponds, cleaning, turbidity, IoT**

I. INTRODUCTION

Super-intensive shrimp pond effluent with a stocking density of 750-1,250 fish/m2 contains an average total suspended solids (TSS) of 798-924 mg/L, dissolved organic matter (BOT) 81,227-88,641 mg/L; total nitrogen (TN) 9.8389-14,4260 mg/L; and total phosphate (TP) 7.8770-11.8720 mg/L [3]. This value has exceeded the threshold limit of the permitted pond wastewater standard so it has the potential to have a negative impact on the environmental quality of the water body receiving the waste load. While the intensity of the impact depends on the cultivation system, type of commodity, water management (amount and frequency of turnover), stocking density applied, quantity and quality of feed used, coastal profile, and characteristics of coastal waters. Characterization of pond wastewater is a prerequisite in determining the carrying capacity of waters for pond development. Based on the potential waste load and its impact, the application of a Wastewater Treatment Plant (WWTP) as part of the cultivation system must be carried out [3]. Previous projects in [4-7] also evaluate the system to improve the system in vannamae pond. [8-12] state the importance of controlling pond's water

Based on the problems and technological sophistication, the author is interested in taking this title because it can make the cleaning system for vaname shrimp aquaculture ponds more intensive by using a turbidity sensor [13] for turbidity readers in shrimp farming ponds and ultrasonic sensors [14] as water level readers in shrimp farming ponds and the use of cameras as detectors. the presence of foam waste in the shrimp farming pond and the Raspberry Pi [15] microcontroller as the control center of the system on the control and monitoring of all sensors then the output data will activate the drain of the remaining shrimp feed and shrimp manure from the drainage to the disposal using a pipe and an automatic faucet that is driven by using a DC power window motor. As well as the disposal of foam waste in shrimp farming ponds by setting the position of the waterwheel capable of collecting all foam waste and removing it using an automatic drain. In this study, a system that can support is proposed, namely research with the title Shrimp Pond Waste Cleaning with Digital Image Processing Using the Internet. Routine pond cleaning is expected to increase production so that it is stable and there is no decline in vannamae shrimp culture.

Based on the formulation of the problem that has been described, this study aims to produce a tool that is capable of cleaning waste in the form of sludge, shrimp feed residue, shrimp feces, and foam in shrimp farming ponds, to produce a tool for cleaning waste in shrimp ponds with a microcontroller, to find out how turbidity sensor design, ultrasonic to detect water turbidity and water level, to find out how the camera detects foam waste with digital image processing

II. METHOD

A. System Design

In the system design section, a description of the system planning that will be made will be explained and the identification of information needs based on the results of observations and literature studies that have been carried out. The system design to be carried out in this study is shown in Fig. 1.

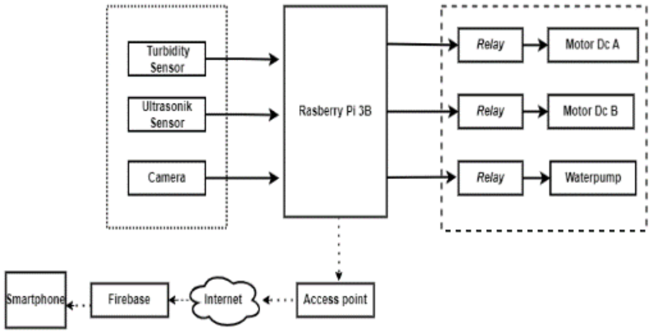

Figure 1. Block Diagram of a foam waste disposal system

The following is a description of each function of the system input and output which is designed based on the block diagram of Figure 1 The camera functions as a foam detector in the surface area of the shrimp pond. The ultrasonic sensor functions as a water level reader in the shrimp pond and the data are sent to the Raspberry Pi. The turbidity sensor functions as a turbidity detector in shrimp ponds and the data will be sent to a smartphone-controlled by the Raspberry Pi. A smartphone is used as a cleaning regulator. When the fry is sown with an average length and weight of 0.8cm and 0.001 gram per head, cleaning is carried out 1 day 1 time. every 2 days. Firebase saves data and sends it to a smartphone. The Raspberry Pi is the control center of all systems for cleaning control devices in shrimp farms. The DC motor functions as a valve actuator for the disposal of foam waste on the surface of the shrimp pond. The relay functions as a switch that works according to the sensor-controlled by the Raspberry Pi. The water pump is used to move the volume of water from the reservoir to the inlet of the shrimp pond. Internet as a sender of Raspberry Pi information to the android application.

B. The System Workflow

The following is a flow diagram of the planned system, shown in Fig. 2. The Turbidity sensor detects the turbidity of the shrimp pond water, the ultrasonic sensor is a reader of the shrimp pond water level and the webcam camera is a detector of foam waste. Data from sensors is collected. The data that has been collected is managed on the microcontroller. Are the data appropriate? If the data match then gets the output value on the sensor and camera, if not eat back to number 2. Get the value from the sensor readings and the foam waste detector. Sending and storing data in the firebase database. Displays the results of the value of water turbidity and water level readings on the Android application.

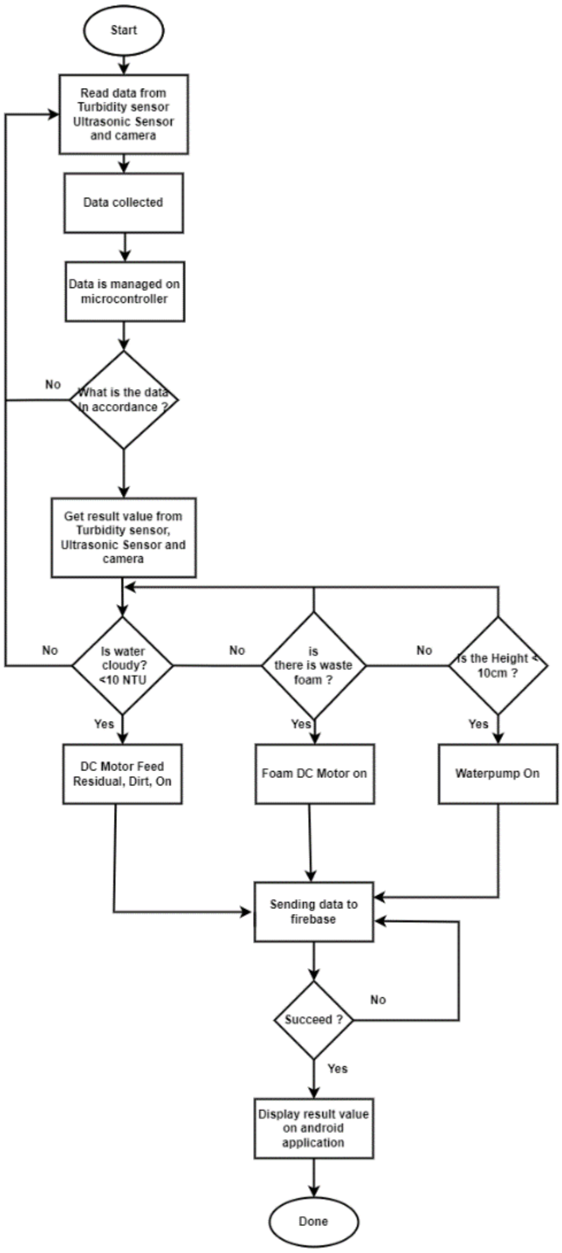

Figure 2 Overall System Flowchart

C. Planning for Hardware and Software Development

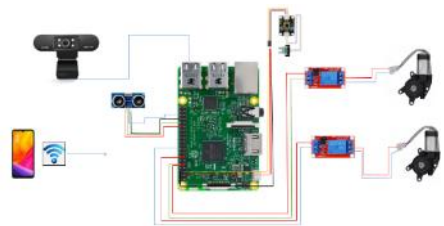

Figure 3 The whole connection circuit

The design of hardware manufacture includes drawings of a series of components that are connected to various other components, as depicted in Figure 3.

1. Camera Series

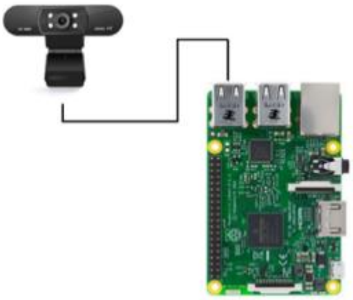

Figure 4 Camera Pin Connection to Raspberry Pi Microcontroller

Figure 4 depicts the camera circuit consists of a Raspberry Pi microcontroller component and a camera for detection in ponds.

2. Ultrasonic sensor circuit

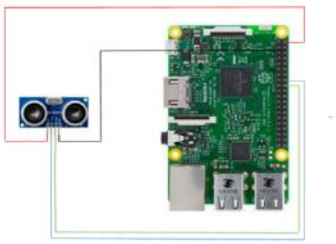

Figure 5 Ultrasonic Sensor Pin Connection to Raspberry Pi mikro microcontroller

The sensor circuit consists of a Raspberry Pi microcontroller component and an Ultrasonic sensor to determine the water level of the pond in shrimp ponds, as depicted in Figure 5.

3. Turbidity Sensor Circuit

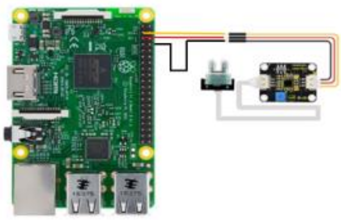

Figure 6 Turbidity sensor pin connection to the Raspberry Pi. microcontroller

The sensor circuit consists of a Raspberry Pi microcontroller component and a Turbidity sensor to determine the turbidity of pond water in shrimp ponds, as shown in Figure 6.

4. Relay Circuit

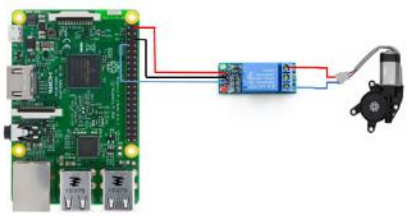

Figure 7 Pin Relay Connection to the Raspberry Pi microcontroller

The relay circuit consists of a Raspberry Pi microcontroller component and a DC motor for driving the opening and closing of the foam waste disposal channel and shrimp manure left over from shrimp feed and changing pond water in shrimp ponds, as depicted in Figure 7.

5. Image Processing Design

The design is done by collecting datasheets and designing software using python 2.7 and OpenCv. OpenCv is an application to process datasheets. After doing OpenCv then a datasheet appears that will be classified for object recognition and there is also a number of each object that will be recognized by the HSV (Hue Saturation Value) Method.

III. RESULTS AND DISCUSSION

A. Hardware Implementation

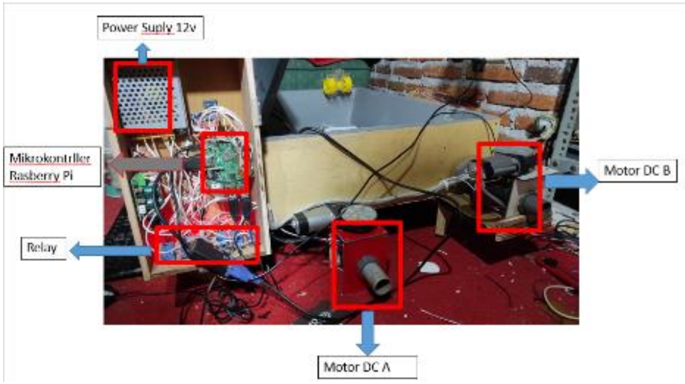

Figure 8 Hardware Implementation

Figure 8 depicts the implementation of the shrimp pond cleaning system that has a feature to take turbidity readings in shrimp ponds and read pond water levels as well as detect the presence of foam waste so that the results can later maintain water quality in shrimp ponds

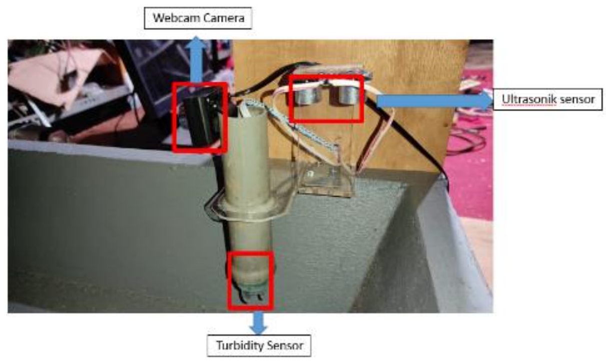

Figure 9 Hardware Implementation of Camera and Sensor Placement

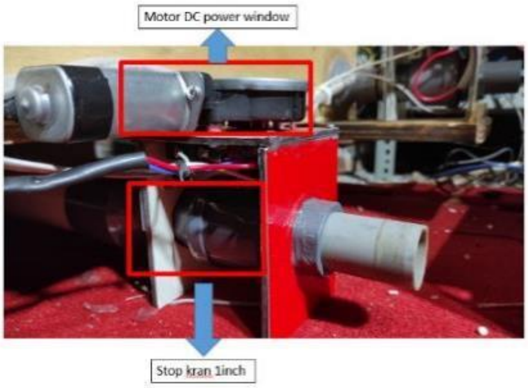

Figure 10 Hardware Implementation of DC Motor Placement and Stop Faucet

System implementation uses a Turbidity sensor to detect turbidity in shrimp farming ponds and an ultrasonic sensor as a water level detector which is then caught by a camera that reads the presence of foam waste in the aquaculture pond which is processed by the Rasbberi Py microcontroller to be read by the user via the Android application. The data that has been obtained is then analyzed to determine the level of success in detecting foam when turbidity occurs in water with a certain volume of water level, as shown in Figure 10.

B. Software Implementation

Figure 11 Software Implementation

Implementation in designing the application aims to display the output of the sensor. In Figure 11 is a display of software implementation in the form of a monitoring application for vaname shrimp ponds. Where the application displays information in the form of foam conditions, water level, and water clarity status.

C. Image processing test results

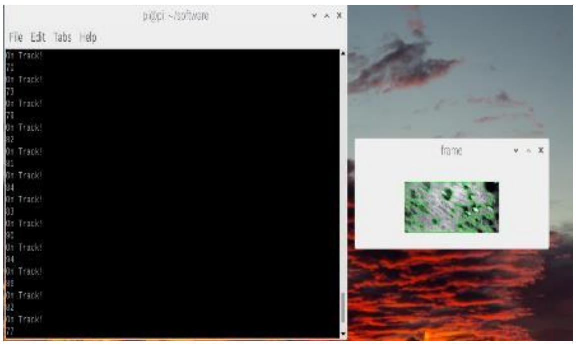

Figure 12 Software Implementation

The image processing test was carried out using foam waste from shrimp ponds. Figure 12 is the result of image processing and the on track value generated from a webcam camera, 10 trials were carried out with a success rate of 67%.

D. Ultrasonic Sensor Test

TABLE I
ULTRASONIC SENSOR ACCURACY

No	Turbidity on Standard Turbidity Meter Measuring Instruments (NTU)	Turbidity on Turbidity Sensors (NTU)	Difference	Presentase Error (%)
1.	8,5	9,3	0,8	9,41
2.	9	9,6	0,6	6,67
3.	9,2	10	0,8	8,70
4.	9.5	10,15	0,65	6,84
5.	11	11,55	0,55	5,00
6.	15,6	16,35	0,75	4,81
7.	17	17,55	0,55	3,24
8.	17,7	18,15	0,45	2,54
9.	18,6	19,3	0,7	3,76
10.	19	19,85	0,85	4,47
	Average Percentage		0,67	5,54

The results of calculations that have been carried out, show the error value obtained when testing is 0.69% following the results of calculations using the formula. The test results of the ultrasonic sensor experiment are shown in table 1. Based on the test results obtained that all experiments are following the conditions given by the ultrasonic sensor, it can be concluded that the accuracy value of the ultrasonic sensor is 0.56%. With a sensor accuracy value of 0.56%, it can be stated that the sensor is feasible to use, as depicted in Table I.

E. Turbidity Sensor Test

TABLE II
TURBIDITY SENSOR ACCURACY

Testing the	Ruler (cm)	Ultrasonic Sensors (cm)	Difference	Error
1	9,5	9,8	0,3	3,16
2	10	10,55	0,55	5,50

Testing the	Ruler (cm)	Ultrasonic Sensors (cm)	Dif-fer-ence	Error
3	10,5	11	0,5	4,76
4	11	11,4	0,4	3,64
5	11,5	11,95	0,45	3,91
6	12	12,05	0,05	0,42
7	12,5	12,9	0,4	3,20
8	13	13,35	0,35	2,69
9	13,5	13,9	0,4	2,96
10	14	14,5	0,5	3,57
	Average		0,39	3,38

The results of calculations that have been carried out, show the error value obtained when testing is 1.18% following the results of calculations using the formula. The test results of the ultrasonic sensor experiment are shown in table 2. Based on the test results obtained that all experiments are following the conditions given by the turbidity sensor, so it can be concluded that the accuracy value of the ultrasonic sensor is 0.51%. With a sensor accuracy value of 0.51%, it can be stated that the sensor is feasible to use, as depicted in Table II.

F. System Test Results

Data collection was carried out for 14 days where the data shown in table 3 is the result of monitoring the condition of the miniature shrimp pond height, as depicted in Table III.

TABLE III
TESTING THE HEIGHT OF THE POOL USING ULTRASONIC SENSORS

No	Date	Pool Height (cm)	Status
1	28 July 2022	12	Waterpump off
2	27 July 2022	11.5	Waterpump off
3	28 July 2022	11	Waterpump off
4	29 July 2022	10.5	Waterpump off
5	30 July 2022	10	Waterpupm on
6	31 July 2022	12.2	Waterpump off
7	1 August 2022	11.59	Waterpump off
8	2 August 2022	10.98	Waterpump off
9	3 August 2022	10.48	Waterpump off
10	4 August 2022	9.75	Waterpupm on
11	5 August 2022	12.5	Waterpump off
12	6 August 2022	11.69	Waterpump off
13	7 August 2022	11.1	Waterpump off
14	8 August 2022	10.47	Waterpump off

Table 3 tests the water level using an ultrasonic sensor by monitoring the water level of the miniature shrimp pond from the movement of the water pump for 14 days from July 28, 2022, to August 8, 2022. 2022 9.75 cm height water pump on to fill the pool water, as depicted in Table IV.

TABLE IV
TESTING THE HEIGHT OF THE POOL USING THE TURBIDITY SENSOR

No	Date	Pool Turbidity (NTU)	Status
1	28 July 2022	17.39	Motor DC Off
2	27 July 2022	15.63	Motor DC Off
3	28 July 2022	13.98	Motor DC Off
4	29 July 2022	9.78	Motor DC On
5	30 July 2022	18.61	Motor DC Off
6	31 July 2022	16.78	Motor DC Off
7	1 August 2022	14.27	Motor DC Off
8	2 August 2022	12.75	Motor DC Off
9	3 August 2022	9.21	Motor DC On
10	4 August 2022	18.14	Motor DC Off
11	5 August 2022	16.78	Motor DC Off
12	6 August 2022	14.74	Motor DC Off
13	7 August 2022	11.23	Motor DC Off
14	8 August 2022	8.91	Motor DC On

From table IV, the turbidity test uses a turbidity sensor by monitoring the turbidity of the miniature shrimp pond water from the water pump movement for 14 days from 28 July 2022 to 8 August 2022. August 3, 2022 turbidity level 9.21 NTU and August 8, 2022 turbidity level 8.91 NTU MotorDC on to perform pool cleaning.

G. Testing Image Processing

Data collection was carried out for 14 days where the data shown in table V is an image processing test detecting shrimp pond foam waste.

TABLE V
TESTING IMAGE PROCESSING

No	Date	Foam Waste Detec-tion	Status
1	28 July 2022	Detected 44%	Motor DC On
2	27 July2022	Detected 52%	Motor DC On
3	28 July 2022	Detected 64%	Motor DC On
4	29 July 2022	Detected 54%	Motor DC On
5	30 July 2022	Detected 74%	Motor DC On
6	31 July 2022	Detected 67%	Motor DC On
7	1 August 2022	Detected 72%	Motor DC On
8	2 August 2022	Detected 77%	Motor DC On
9	3 August 2022	Detected 69%	Motor DC On
10	4 August 2022	Detected 73%	Motor DC On
11	5 August 2022	Detected 61%	Motor DC On
12	6 August 2022	Detected 68%	Motor DC On
13	7 August 2022	Detected 79%	Motor DC On
14	8 August 2022	Detected 81%	Motor DC On
Foam Waste Detection Average 67%			

From Table V, the image processing test was carried out by looking at the percentage of foam in the shrimp pond using a webcam camera. From the table, the average percentage of foam waste detection is 67%. The cause of the foam waste in the shrimp pond is the excess administration of dolomitic lime and leftover feed.

H. Packet Loss Test

Testing the success rate of data transmission can be done by calculating the packet loss sent from the Rasberry Pi microcontroller to the Firebase. Table VI is a packet loss test for sending data from the Rasberry Pi to Firebase.

TABLE VI
PACKET LOSS TEST

Package Delivery to Firebase	Firebase data
1	Update
2	Update
3	Update
4	Update
5	Update
6	Update

Package Delivery to Firebase	Firebase data
7	Update
8	Update
9	Update
10	Update
11	Update
12	Permanent

The results of calculations that have been carried out, shows that the packet loss value obtained when testing is 8% following the results of calculations using the formula. Based on table 6 of the 12 packets sent, there was 1 failed packet and 11 succeeded with a success percentage of 92% with a packet loss of 8% where the quality of packet delivery was good.

I. Delay Test

Delay testing is needed to see if the communication system in this final project is running well or not. Wireshark can display several packets when doing live streaming because the protocol used is TCP, therefore it must be filtered first. Do a filter according to the IP used. The IP used by the Raspberry pi on the access point used is 192.168.46.152 and the website IP is 34.120.160.131

TABLE VII
TESTING DELAY

Sending Packages To Firebase To	Raspberry Pi IP	Application IP Monitoring (Dst)	Delayed (ms)
1	192.168.46.152	34.120.160.131	0.0020
2	192.168.46.152	34.120.160.131	0.0021
3	192.168.46.152	34.120.160.131	0.0022
4	192.168.46.152	34.120.160.131	0.0024
5	192.168.46.152	34.120.160.131	0.0026
6	192.168.46.152	34.120.160.131	0.0029
7	192.168.46.152	34.120.160.131	0.0031
8	192.168.46.152	34.120.160.131	0.0025
9	192.168.46.152	34.120.160.131	0.0022
10	192.168.46.152	34.120.160.131	0.0027
Average			0.0025

Table VII is the result of the packet calculation with the average delay obtained is 0.0025 ms, it can be seen that the delay test results are very small. The smaller the delay, the better the quality of data transmission because there is no delay in information.

IV. CONCLUSION

The design of a pond to collect organic waste by designing a shrimp pond was successfully carried out by adjusting the height on the surface of the pond and placing the waterwheel position at the end to concentrate the foam waste at the disposal.

The manufacture of a foam waste cleaning tool was successfully carried out by utilizing a webcam as a detector of foam waste, a turbidity sensor as a water turbidity detector, an ultrasonic sensor as a water volume detector, and central drainage as a disposal of feed residue and shrimp manure into the sewer.

The manufacture of automatic cleaning tools is carried out using a turbidity sensor, an ultrasonic sensor where the turbidity sensor for detecting water turbidity obtained an average of 0.51%. The addition of the volume of water in the shrimp pond is done using ultrasonic sensors and water where the ultrasonic sensor obtained an average of 0.56%. As for the detection of foam waste using a webcam camera as a foam detector.

Digital image processing to detect foam waste is done by creating a datasheet and OpenCV as a library for processing and classifying objects using the HSV (Hue Saturation Value) method.

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