Vanname Shrimp Health Monitoring System Using Internet of Things-based Image Processing Method

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***Abstract*— Viruses are known to have attacked vaname shrimp, shrimp infected with the virus showed several abnormal things, including the appearance of a reddish color on the shrimp's body, and redness on the shrimp's tail. In healthy Vannamei Shrimp, the shrimp body shows a brownish color, and there is no reddish color on the tail and body of the shrimp. Implementation of a prototype of a shrimp health monitoring system needs to be done to determine the health condition of shrimp. This final project will produce a prototype that can monitor shrimp health, by adopting Artificial Intelligent (AI) learning technology for image processing and recognition. Presenting a prototype consisting of hardware and software analysis of healthy Vannamei shrimp for the purpose of monitoring the health of Vannamei shrimp thereby increasing the productivity of the Internet of Things (IoT) based ponds.**

***Keywords*— Image processing, Internet of Things (IoT), Monitoring system**

I. Introduction

Disease is a major obstacle in the cultivation development effort because it can pose a relatively high threat of death [1]. Vannamei shrimp cultivation business cannot be separated from the presence of disease. Various viruses are known to have attacked many vannamei shrimp, including the reddish disease syndrome in the tail of shrimp. Therefore, early detection of infected shrimp is important to determine the health condition of shrimp to prevent secondary infection. The route of infection includes factors such as predation by environmental organisms and water-borne infection. Shrimp infected with the virus exhibited three abnormal behaviors: 1) appearing in shallow areas of shrimp ponds during the early stages of infection, even while feeding, 2) not eating, and 3) redness of the tail and body of the shrimp [2]. Delayed detection will cause problems in shrimp health.

Implementation of a prototype of a shrimp health monitoring system needs to be done to determine the health condition of shrimp. This final project will produce prototype that can monitor shrimp health, by adopting Artificial Intelligent (AI) learning technology for image processing and recognition.

The algorithm design uses YOLO (You Only Look Once) a method produced by Joseph Redmon to perform Object Detection. YOLO can perform Object Detection in real time, when compared to other object detection systems YOLO has higher FPS and MAP [3]. Providing a histogram as a color extraction to distinguish healthy and sick shrimp. Objects that will be classified are healthy and sick vanname shrimp.

Based on this background, in this research, the vanname shrimp health monitoring system uses image processing. Monitoring results will be displayed on the PC and web server.

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II. Method

A. Monitoring System Healthy Vanname Shrimp

The design of the vanname shrimp health monitoring system uses image processing based on the Internet of Things (IoT). Using a Raspberry Pi microcontroller that has been installed with Tensorflow and Keras as the Deep Learning Computer Vision and using the Raspbian OS. The result of this processing is that the health detection of fresh white vaname shrimp will show a grayish color of shrimp and unhealthy shrimp will have a reddish color on the body of the shrimp.

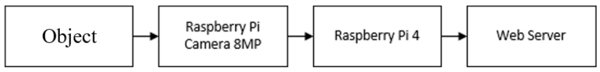

Figure 1. Block Diagram Design System

Block diagram of data retrieval carried out using an 8MP Raspberry Pi Camera connected to a raspberry pi 4 microcontroller to detect vanname shrimp. The data on the health monitoring results of vanname shrimp will be displayed in real time on the web server.

B. Software Design

At the training stage, the system is given input in the form of images of healthy and unhealthy vaname shrimp. At the preprocessing stage, resizing is done to change the image size by reducing the image size horizontally or vertically.

Convolutional layer functions to extract image features and learn important parts that can be characteristic of the object and create a feature map of the object [4]. The feature map that has been created on the convolution layer is to predict objects and predict the bounding box of the object which is divided into 2 convolution layers where 1 layer is responsible for detecting the location of the object and 1 layer functions to predict the bounding box. Pooling is a layer that is responsible for equalizing the size of the feature map and region proposals that have been processed and sending feature map information to be classified in the classification layer [5]. The classification layer is a layer to group objects that have been detected and perform labeling and bounding boxes on objects [6].

In the Testing stage, the system load model is the stage the system will reload the model that has been stored during the training session. In the frozen graph, the input data received through the camera will be processed on the graph stored in the frozen model to identify and assign a bounding box based on the weight that has been stored in the model that has been trained and objects that have been classified are given a bounding box and label.

C. Design Hardware

Design hardware is shown in Figure 2. A square wooden board with a size of 45 cm x 45 cm was used as the placement of the test object. The components used in the prototype include an 8MP Raspberry Pi camera and a laptop screen as a display. The following is the result of designing a prototype of vanname shrimp health hardware.

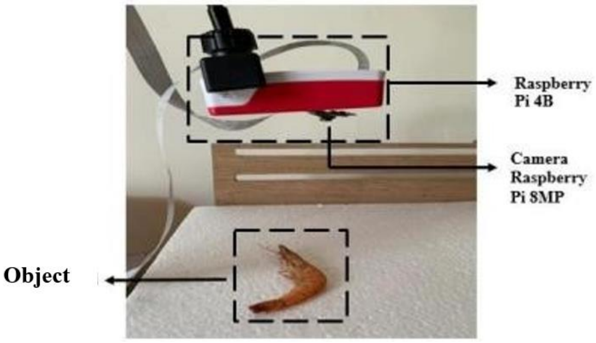

Figure 2. Prototype Monitoring Sistem Vanname Shrimp

Prototype of the vanname shrimp health monitoring system consisting of a Raspberry Pi 4B and an 8MP Raspberry Pi Camera. To perform the detection, the user places the vanname shrimp on a tray with a position just below the camera lens. The shrimp detected by the camera will be displayed on the laptop monitor with a description of healthy or sick vanname shrimp.

The schematic of the design for monitoring the health of Vanname shrimp is shown in Figure 3

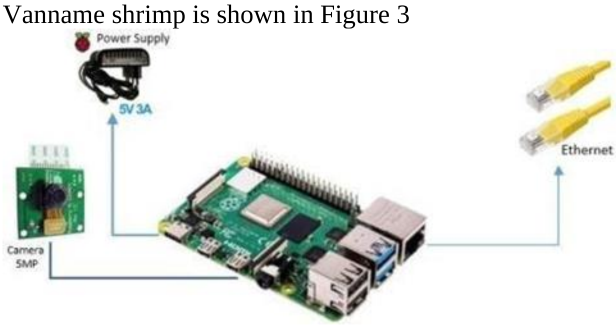

Figure 3. Schematic of the design for monitoring the health of vannamei shrimp

III. RESULTS

In this study, a simulation was carried out using a laptop to detect healthy vannamei shrimp and sick vannamei shrimp. Applying the YOLO (You Only Look Once) method with image sources from the data collection (dataset) of healthy vanname shrimp and sick vanname shrimp [7]. The image training data samples were characterized using Python software, then image recognition was carried out in ideal conditions through direct camera recording.

A. Vanname Shrimp Image

Taking pictures of vannamei shrimp is done with 2 (two) different objects, unhealthy vannamei shrimp and healthy vannamei shrimp, with the following examples:

(A) (B)

Figure 4. Image Variations on Vaname Shrimp. (A) Vanname Shrimp (B) Healthy Vanname Shrimp

Figure 4 shows picture of vannamei shrimp with variations of healthy vannamei shrimp (there is a gray color on the shrimp body) and unhealthy vanname shrimp (the shrimp body has a red color). The main object for detection is placed on a flat plane by giving a white base so that the system can detect clearly, and the lighting is sufficient or evenly distributed and not too bright so that the light does not give a white blur due to reflections from light.

B. Training Dataset

Training dataset on vanname shrimp is carried out starting from the image data collection that will be used in the training process and will be put into a different folder, which is separated from the healthy vanname shrimp folder and the unhealthy vanname shrimp folder. Image data of 350 healthy vanname shrimp and 300 photos of unhealthy vanname shrimp will be used as image recognition datasets.

The image data training process to take special features and shapes that will be used by YOLO to recognize objects during the classification process [8]. Training is done on google colab. The training process takes approximately 5 hours to identify the characteristics and shapes of healthy and unhealthy vannamei shrimp. Samples that have been trained will be converted which will then output the detection results of vanname shrimp objects, both healthy and unhealthy.

C. Results on Healthy Vanname Shrimp

- Testing with a distance of 20 cm

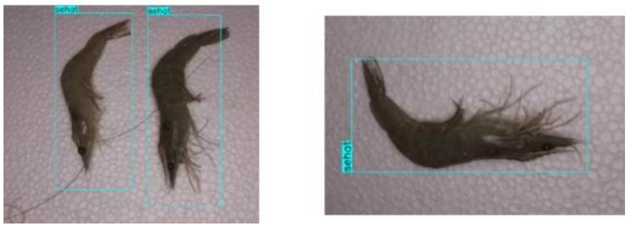

Figure 5. Detection results with a distance of 20 cm

- Testing detection distance of 20 cm with histogram results

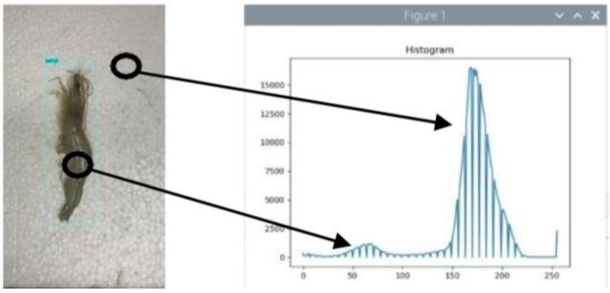

Figure 6. Detection results and histogram graph at a distance 20cm

Shrimp is placed on a tray that has a white base color. In the pixel range 150 to 200, the histogram depicts the color of the white tray and at pixels 50 to 100 there is an increase in the graph depicting the shrimp object.

TABLE 1.
TABLE OF HEALTHY SHRIMP EXPERIMENT 20 CM

Length	Actual Amount	Detected Amount	TP (True Positive)	FP (False Positive)	FN (False Negative)
20 cm	1	1	1	-	-
	2	2	2	-	-
	3	3	3	-	-
	4	3	3	-	1
	5	4	4	2	-
Total			13	2	1

Accuracy=$\frac{TP}{TP+FN+FP} x\ 100\% = \frac{13}{13+1+2} x\ 100\% = 81\ \%$

In the detection experiment with a distance of 20 cm using healthy shrimp optimally the camera can correctly detect the actual number of 3 shrimp exceeding that, for example the actual number of 4 or 5 shrimp there are shrimp that cannot be detected or can detect but not according to accuracy. In the detection of shrimp with a distance of 20cm obtained an accuracy of 81%.

- Testing on Healthy Vanname Shrimp

Figure 7. Detection result with a distance 20 cm

Based on Figure 8. detect vanname shrimp with a distance of 30cm using a raspberry pi camera to detect healthy shrimp with gray body characteristics.

- Testing with a distance 30 cm with histogram result

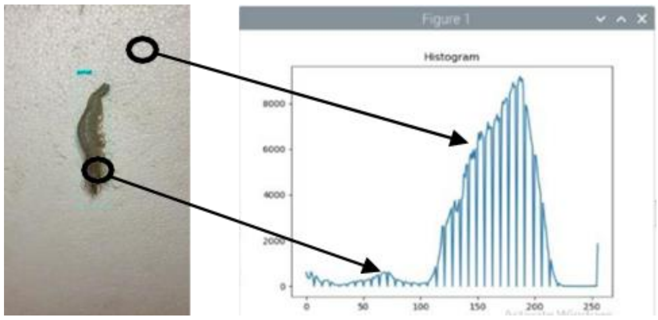

Figure 8. Detection result and histogram graph at a distance 30 cm

Shrimp is placed on a tray that has a white base color. In the pixel range of 100 to 200, the histogram of the color of the white tray is displayed and at pixels 50 to 80, there is an increase in the graph depicting the shrimp object.

TABLE 2.
TABLE OF HEALTHY SHRIMP EXPERIMENT 30 CM

Length	Actual Amount	Detected Amount	TP (True Positive)	FP (False Positive)	FN (False Negative)
30 cm	1	1	1	-	-
	2	2	2	-	-
	3	3	3	-	-
	4	4	4	-	-
	5	5	5	-	-
Total			15	0	0

Accuracy=$\frac{TP}{TP+FN+FP} x\ 100\% = \frac{1315}{15+0+0} x\ 100\% = 100\ \%$

Vanname shrimp detection was carried out with variations in distances of 20cm, and 30cm. In calculating the accuracy by looking at the results of False Negative (FN), False Positive (FP) and True Positive (TP) it produces high accuracy values at a distance of 30cm with 100% accuracy [9]. However, to detect a hot microcontroller, it will be difficult to detect objects.

D. Results on Unhealthy Vanname Shrimp

- Testing with a distance of 20 cm

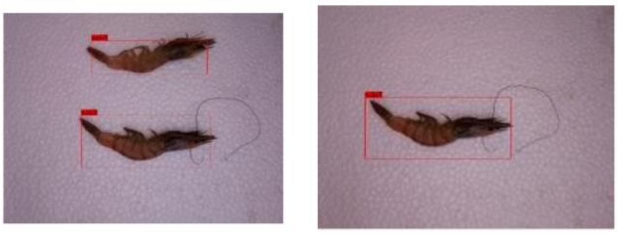

Figure 9. Detection result with a distance 20 cm

Detection vaname shrimp with a distance of 20 cm using a raspberry pi camera to detect unhealthy shrimp that have red shrimp body characteristics.

- Testing detection distance of 20 cm with histogram results

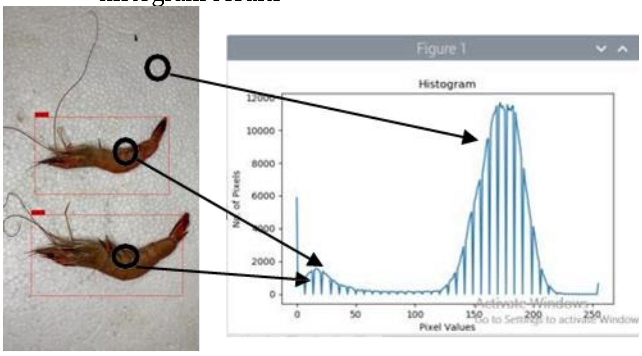

Figure 10. Detection results and histogram graph of unhealthy shrimp at a distance of 20 cm

Shrimp is placed on a tray that has a white base color. In the 150 to 200 pixel range, it has the highest pixel which represents the histogram of the white tray color. At pixel 0 the graph rises to 6000 no pixels, at pixels 0 to 40, there is an increase in the graph that decreases until pixel 100 has the lowest graph depicting a shrimp object.

TABLE 3.
TABLE OF HEALTHY SHRIMP EXPERIMENT 20 CM

Length	Actual Amount	Detected Amount	TP (True Positive)	FP (False Positive)	FN (False Negative)
	1	1	1	-	-
	2	2	2	-	-
20 cm	3	3	3	-	-
	4	3	2	-	1
	5	3	2	3	-
Total			10	2	1

$$\text{Accuracy}=\frac{TP}{TP+FN+FP}\,x\ 100\% = \frac{10}{10+1+3}\,x\ 100\% = 71\ \%$$

Based on vanname shrimp detection experiment, it was carried out with a distance variation of 20cm. In calculating the accuracy by looking at the results of False Negative (FN), False Positive (FP) and True Positive (TP) resulting in a high accuracy value at a distance of 20cm using unhealthy shrimp, an accuracy result of 71% is obtained.

- Testing with distance 30 cm

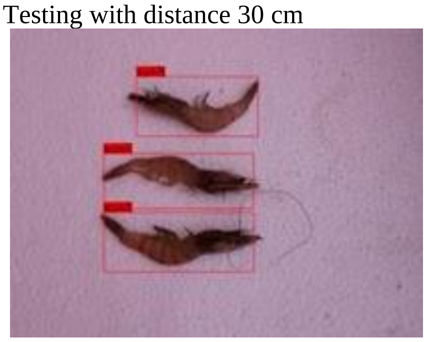

Figure 11. Detection results with a distance of 30cm Experiment to detect vanname shrimp with a distance of 30cm by taking 3 and 2 shrimp objects as detection using a raspberry pi camera to detect unhealthy shrimp that have red shrimp body characteristics.

- Testing detection distance of 30 cm with histogram results

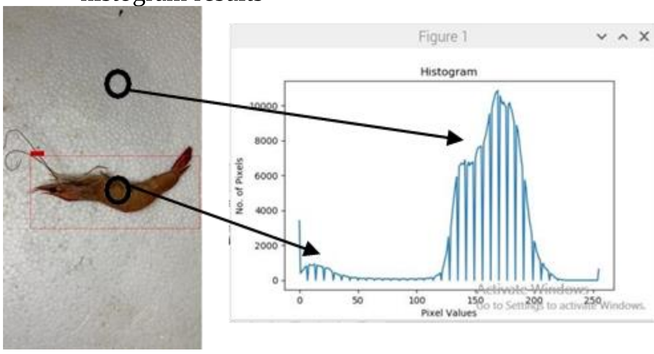

Figure 12. Detection results and histogram graph of unhealthy shrimp at a distance of 30cm

Shrimp is placed on a tray that has a white base color. In the pixel range of 120 to 200 has the highest pixel which represents the histogram of the color of the white tray [10]. At pixel 0 the graph rises to 4000 no pixels, at pixels 0 to 40 there is an increase in the graph that decreases until pixel 100 has the lowest graph depicting a shrimp object.

TABLE 4.
TABLE OF HEALTHY SHRIMP EXPERIMENT 20 CM

Length	Actual Amount	Detected Amount	TP (True Positive)	FP (False Positive)	FN (False Negative)
	1	1	1	-	-
	2	2	2	-	-
20 cm	3	3	3	-	-
	4	3	3	-	-
	5	4	3	1	-
Total			13	1	0

$$\text{Accuracy}=\frac{TP}{TP+FN+FP}\,x\ 100\% = \frac{13}{13+0+1}\,x\ 100\% = 92\ \%$$

From the vanname shrimp detection experiment, it was carried out with a distance variation of 30cm. In calculating the accuracy by looking at the results of False Negative (FN), False Positive (FP) and True Positive (TP) resulting in a high accuracy value at a distance of 30cm using unhealthy shrimp, the accuracy result is 92%.

E. Web Server Display

The following is a web server display that has been integrated with the Vanname shrimp health image processing program for a display that functions to display monitoring data in real time.

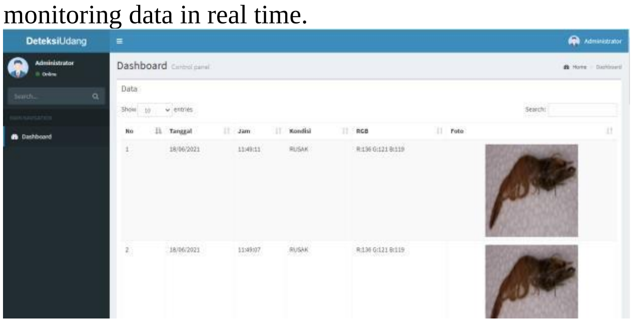

Figure 13. Vanname shrimp health monitoring display

Display on a web server that displays data on the health monitoring results of vanname shrimp in real time. On the Web Server there are several features such as the date of collection, time, description of the condition of the shrimp and photos of the detected vanname shrimp.

IV. Conclusion

Performance testing on YOLO vanname shrimp image processing was carried out by testing accuracy, with variations in distance of 20cm and 30cm. At a distance of 30 cm shrimp can be detected clearly and has an accuracy of 98%. Using the Histogram as an extraction on healthy shrimp with the results of a pixel range of 150 to 200 depicting the histogram of the white tray color and at pixels 50 to 100 there is an increase in the graph depicting the shrimp object. In sick shrimp, the pixel range of 120 to 200 has the highest pixel which represents the histogram of the color of the white tray. At pixel 0 the graph rises to 4000 no pixels, at pixels 0 to 40 there is an increase in the graph that decreases until pixel 100 has the lowest graph depicting a shrimp object.

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