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Detection of Megalopa Phase Crab Larvae Using Digital Image Processing

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***Abstract*— Blue Swimmer Crab has high economic value as an export commodity. One of the problems that occur in crab culture is cannibalism during the larval development phase. Megalopa phase crab larvae tend to eat zoea phase crab larvae due to inadequate feeding. To avoid cannibalism in the crab larvae development phase, farmers need to check the development of larvae regularly and separate the megalopa phase crab larvae from zoea phase crab larvae. Checking is done by looking directly at the rearing tank, which is time-consuming and difficult because the phase changes in the crab larvae are unpredictable. This research focuses on the detection process of the megalopa phase crab larvae using a convolutional neural network (CNN) method. This research uses 210 images, and detection results get shown an average accuracy of 87.7%.**

Keywords—CNN, Crab Larvae, Detection, Image Processing, Megalopa.

I. Introduction

Blue Swimmer Crab has high economic value as an export commodity. The wide distribution of blue swimmer crabs, blue swimmer crabs that spawn throughout the year, crab eggs, which reach more than 1 million for each parent. However, the natural conditions with the long life of the bivalve cause significant losses are the reason for crab cultivation. One of the problems that occur in crab cultivation is cannibalism in which the megalopa phase crab larvae tend to eat zoea stage crab larvae due to inadequate feeding when the portion of food is not given sufficiently [1]. The Larvae development phase of the crab consists of four phases of *zoea* and a megalopa phase [2]. Cannibalism may occur after the tenth day during the maintenance period. In this period, the size of crabs is not uniform because the digestibility and nutritional requirement of the larvae vary. The cannibalism can be avoided by providing shelter in the form of shelter and the suitable base substrate, grading, and reduction of larval density during maintenance [3].

In traditional farming, to avoid cannibalism in the crab larvae development phase, farmers need to check the development of the crab larvae phase regularly and separate the megalopa larvae from zoea larvae. Checking is done conventionally by looking directly into the tank of larvae during maintenance that leads to time-consuming. Therefore, the use of digital image processing is needed to determine the phase of crab larvae effectively.

Digital image processing technology began to be applied in the field of aquaculture. Implementation of remote fish disease video diagnosis expert system. The expert system is designed to obtain accurate and timely diagnosis results for fish diseases from remote experts, the system can accurately transmit aquaculture environmental conditions, fish disease characteristics, and anatomical details to online experts. Experts can make accurate fish disease diagnoses and provide effective treatment measures through information constraints[4]. The image processing technology is applied to identify EUS (Epizootic Ulcerative syndrome) disease caused by bn Aphanomyces invadans, pathogenic fungi. Using fish images in the segmentation process is used edge detection to obtain morphological information of fish. At the feature extraction stage using feature descriptors such as HOG (Histogram of Gradient), FAST (Features from Accelerated Segment Test) and image classification of fish infected with EUS and NON-EUS using machine learning algorithms. PCA used helps improve accuracy. Implementation using MATLAB software automatically detects and diagnoses EUS in fish[5]. Research on automatic fish seed counting using image processing techniques and investigated the effectiveness of the Convolutional Neural Network (CNN) in detecting fish and the accuracy of the calculations. The result of the experiment shows that CNN can be used in hatchery production, detection rates, and high calculation accuracy [6].

Image processing and detection using Deep Learning have been widely used today. In this research, we use the CNN method to detect the development of crab larvae, especially megalopa phase larvae in crab farming.

II. Proposed Method

In data collection, crab larva images have a small size in the Zoea 1 phase that has a length of 0.44 mm to 054 mm, Zoea 2 has a size of 0.72 mm to 0.77 mm, Zoea 3 has a size of 0.79 mm to 0.87 mm, Zoea 4 has a size of 0.98 mm to 1.06 mm and the

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megalopa phase has a size of 1.69 mm to 1.81 mm [7]. Previously, at the stage of the detection and classification process, we used the Support Vector Machine (SVM) method to detect crab larvae, but with the size of larvae images in the dataset, miss detection, and classification often occur between the megalopa phase and the non-megalopa phase. Then we used the CNN method for the same images, and the CNN method can detect megalopa phase larvae better than the SVM method. Therefore, in this study, we use the CNN method.

The general design of this system divided into image data retrieval and then proceed with object detection and classification. The final stage of this process is in the form of an evaluation of the classification results. Block diagrams can be seen in fig.1.

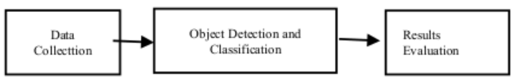

Fig.1. General design of the diagram block

A. Data Collection

The format of input image data used in this study is JPG format. We use the Logitech BRIO Webcam to produce images with high resolution. The image size provided by the webcam is 4096 x 2160 pixels. The use of a webcam is intended to control the process of taking pictures and support electrical power simpler and easier to manage. We placed the webcam in a position drowned at a depth of 1 to 3 cm from the surface of the water. The webcam is protected by acrylic to prevent being exposed to water and to reduce the noise resulting from shooting due to the reflection of light on the surface of the water, waves of water, and other disturbances due to the aeration process. The Raspberry Pi computer controls the webcam for taking pictures every 10 seconds and stores the image data on the hard drive.

Fig.2. Image data capture scenario

B. Object Detection and Classification

We classify the object to be detected into two categories, i.e., megalopa phase larvae and non-megalopa phase larvae, and the object detection process uses the CNN method. At the stage of the classification process, drawing training is carried out based on the number of categories performed as many as 4000 times iteration. The CNN method requires substantial computation power. Therefore, we use the high-specification Graphical Processing Unit (GPU) and PC technology, i.e., NVIDIA CUDA (Compute Unified Device Architecture), which is faster in the process of training image data.

1) Graphic Processor Unit (GPU) Architecture

GPU programming is used to process graphics, but it can also be used for scientific computing using machine learning or with specific frameworks such as CUDA (Compute Unified Device Architecture). GPU has an architecture in which GPU is a multi-trade processor that can run millions of data processing at the same time [8]. GPU technology combined with several other technologies on specific operating systems such as Windows 10, CUDA, CNN method, and OPENCV.

2) Archite Compute Unified Device (CUDA)

CUDA is a framework of the C programming language that can communicate directly with the GPU for multithreading parallel execution. The platform often add native support to new GPU architectures by supporting the computational capabilities of that architectural version, new versions of the CUDA platform usually also include software features that are not dependent on hardware manufacturing [9]

3) The concept of using the CNN method in the process detection

In this method, the algorithm steps as follows:

1. Input image
2. The image is divided into a grid of cells, the 416x416 grid in general. Each of these cells is responsible for predicting bounding boxes.
3. In each grid cell containing five values, namely the location of coordinates x, y, width and height of bounding box in w, y and confidence value (x, y, w, h, c) to nB expressing the number of bounding boxes
4. Each grid predicts the possibility of a confidence value (C). Possible reflexes for the confidence scores of a model include the target object and the accuracy of the detection box prediction.

   $$C(Object) = Pr(Object) \times IOU(Pred,Truth) \quad (1)$$

   IOU is the overlapping number of candidate bound in general and the ground truth bound, the ratio of intersection and union

   $$IOU(Pred, Truth) = \frac{area(box_{truth}) \cap area(box_{prod})}{area(box_{truth}) \cup area(box_{prod})} \quad (2)$$

   After getting confidence from each box prediction, the lowest value of the box prediction is deleted with the threshold value. Then the non-maximum emphasis is in the form of the remaining bounding box.[10]
5. The bounding box describes the rectangle that encloses an object. The bounding box is predicted to have a score where the higher the trust score makes the box lines drawn stronger
6. For each bounding box, the cell also predicts the class with the expected score value. The highest score in one class will be the prediction result of the object class. Classes classified in this research are megalopa and non-megalopa.

III. EXPERIMENT AND RESULT

The crab larva dataset is used at the time of the experiment. Image data used during the training process were 200 images for all phases and ten images during the test process. The number of iterations during the training process was 4000 iterations with a learning rate of 0.001, with an average loss of

0.3. The experimental is conducted using PC with intel® Core™ i7-6700HQ 2.6GHz RAM 16 GB 64bit Operating System Windows 10, NVIDIA GeForce GTX 960M, CUDA, Darknet Framework.

The stages of the training process are as follows:

1) Marking/Labeling (Annotation Image)

In the process of image annotation, we collected 200 images in which the larval object in the megalopa phase and non-megalopa. The number of classes follows the object category that will be detected. In this case, there are two classes, namely non-megalopa class and megalopa class. In this annotation process, each larval object in the image will be given a limiting contact according to its class category. The annotation process uses a tool called the YOLO mark[11]. This process will produce output in the form of a data containing information about the location of the boundary box and its label in the form of a text file format as seen fig.3.

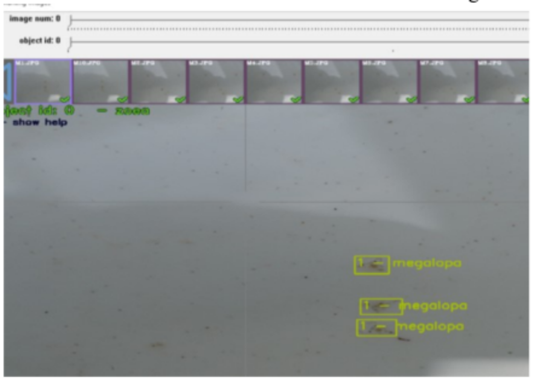

Fig.3. Labelling process of system.

2) Training

At this stage, the training process uses the framework from darknet [12]. This framework uses a model consisting of network code and pre-training weights from the network. The code file for the model is a file with a * .cfg extension, and a pre-training file is a file with a *.weights extension. Before the training process, an adjustment is made to the *.cfg file to set the number of classes, iteration restrictions, memory usage, and so on. The training process is carried out by utilizing tools, namely Google Collab and using GPU for computing, so the training process becomes faster. The results of this training process will produce a final weight file in the *.weights extension, which will be used to carry out transfer learning when it will be detected.

3) Prediction and Detection.

The prediction and detection process is carried out by utilizing darknet compilation file, the model code file (* .cfg) used during the training process, and the final weight file of the training result (*.weight). The transfer learning process is carried out by executing commands that utilize all three files and image files that will be used for prediction of detection of megalopa objects and not. The result of the command execution is the same image with the addition of objects that have been marked in a box. These results are also named according to their categories.

Tests were carried out on ten images where the images have different larval densities and contain both megalopa and non-megalopa objects. Fig.4 shows the results of the detection and classification test of crab larvae and the accuracy was got with an average value of 87.7% as seen in Table 1. The detection time for the system was 1.2 seconds

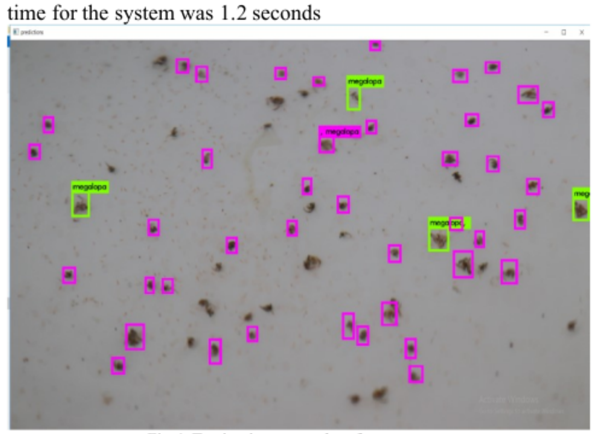

Fig.4. Testing image results of system.

Table.1 Accuracy result of predicted Megalopa by the system

Image	Number of Megalopa		Accuracy (%)
	Real	Predicted	
1	4	3	75.00
2	13	11	84.62
3	2	2	100.00
4	3	3	100.00
5	11	9	81.82
6	5	4	80.00
7	12	11	91.67
8	9	8	88.89
9	12	11	91.67
10	6	5	83.33
Average Accuracy			87.70

The calculation of accuracy in this study is by comparing the test data from the system with the results of calculations manually using the following formula:

$$\text{Accuracy} = \frac{\text{Predicted number of megalopa}}{\text{Real number of megalopa}} \times 100\% \qquad (3)$$

IV. CONCLUSION

The paper describes the application of image processing detects the megalopa phase crab larvae. Detection aims to assist the farmer in separating the megalopa phase crab larvae from zoea phase crab to avoid cannibalism. The dataset used in this research was 200 for training data and 10 for testing data. Data is taken using Logitech BRIO Webcam. The detection method used is CNN with 4000 iterations, and the learning rate was 0.001. The result showed an average accuracy of 87.7% and average times of 1.2 seconds. Therefore, the CNN method could be used to detect the Megalopa phase crab larvae. In the near future, we will provide a notification system to the farmer when the system has detected larvae that have entered the megalopa phase. Therefore, farmers can immediately take further action by separating the megalopa phase crab larvae to avoid cannibalism on the larvae, which can increase the survival rate of crabs that can be harvested.

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