

Background :

To address food security, the number of aquaculture activities for offshore and onshore fish and prawn farming have increased significantly in ASEAN countries for the last 20 years. However, the production rate from small medium enterprise has been low especially for onshore prawn aquaculture. Farmers are still rely on traditional manual approach to monitor the growth of the cultures and manage the ponds. In this interdisciplinary project, an AI based recognition system is proposed to monitor the growth of *Macrobrachium Rosenbergii* using video images and sensors data taken from production aquaculture ponds with different water qualities



Speaker: Tiong Hoo Lim (UTB, Brunei)



Project Members :

Leader: Tiong Hoo Lim (UTB, Brunei) Members:

- Dr Aida Maryam Basri (UTB, Brunei),
- Dk Dr Najeebah Az-Zahra Tashim (UTB, Brunei),
- Wafiq Abd Zariful (UTB, Brunei),
- Suriayati Chupra (UTM, Malaysia),
- Seno Adi Putra (Telkom U, Indonesia),
- Hanif Fakhrurroja (IIS, Indonesia)

Project Duration :

12 Months – Extended 12 months (24 Months)

Project Budget:

USD \$38,100

Associate Project Members:

Mr Zuhairi Hj Azahari (ODE, Aquaculture and Agriculture Company, Brunei),

Dr Aqilah Junaidi (Fisheries Department, Ministry of Primary Resource and Tourism, Brunei),

Dr Peng Cheng Liu (University of York, UK)



- Development of IoT Aquaculture Pond (Real and Control) (UTB, BRIN, TELKOM)
- The study of prawn growth using IoT technologies (BRIN, TELKOM and UTB)
- The use of CNN algorithm such as YOLO for the Classification of prawn age (ALL)
- Extra small, Small, Medium, Large, Extra large
- The detection of prawn age/size/weight using Artificial Intelligence, camera and distance sensor (UTB, UTM, TELKOM, UoY)
- The study of prawn growth: Nutritional analysis, length and weight correlation (UTB, UTM)



Devolopment and Deployment of IoT aquaculture farm

- Dr Lim Tiong Hoo (UTB)
- Seno Adi Putra (Telkom U, Indonesia),
- Hanif Kafhrurroja (BRINS, Indonesia)
- Suriayati Chupra (UTM, Malaysia),
- Wafiq Zariful (UTB)

Construction and optimization of the prawn growth model using machine learning

- Dr Lim Tiong Hoo (UTB)
- Suriayati Chupra (UTM, Malaysia),
- Seno Adi Putra (Telkom U, Indonesia),
- Hanif Kafhrurroja (BRINS, Indonesia)
- Dr Peng Cheng Liu and team (University of York, UK)
- Wafiq Zariful (UTB)

Study of the prawn quality and growth - Sampling for data training and Analysis

- Dr Lim Tiong Hoo (UTB)
- Aida Maryam Basri (UTB, Brunei),
- Najeebah Az-Zahra Tashim (UTB).

Stakeholder information sharing

- Mr Zuhairi Hj Azahari (ODE, Aquaculture and Agriculture Company, Brunei) Access to the pond
- Dr Aqilah Junaidi (Fisheries Department, Ministry of Primary Resource and Tourism, Brunei) Expert advice on the current breeding environment



Project Activities:

Research Visit to Telkom University and BRIN, Indonesia 2023



Research Visit to University of York, UK 2023





Project Activities: Solar Powered IoT Water Quality Monitoring



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Project Activities: Alquatic

Alexatia	Welcome to Visual Representation for Dissolved						
Alquatic	Oxygen, pH and Temperature Sensor Readings			min	1.01		29.7
				25%	1.27	0	29.9
	Dissolved Oxygen (mg/L)			50%	1.54	0	30.4
	5 15			max	2.19	0	31.3
AlFood Systems	6.3	Alguati	Alguati				
		Alguatiz	Alquuit	Date & Time Am	nonia Dissol	ved Oxygen T	emperature p
		-	-	2024-10-21 12:20	0	1.47	30.1
Water Quality				2024-10-21	0	1.28	30.1
	© 1			2024-10-21	0	1.49	30.1
Prawn Length Estimation				12:10 2024-10-21			3011
				12:05	0	1.93	30.1
	40	Select Role:	👌 Water Quality	12:00	0	2.13	30
	28.6			2024-10-21 11:55	0	1.41	30
	0			2024-10-21	0	2.08	30
			Station	2024-10-21	Û	1 46	30
0.D.E.			Prawn Biomass	11:40			
1		Farmer	Estimation	11:35	0	1.4	30
				2024-10-21 11:30	0	1.32	30
					44	< <u>1</u> /	26 > >>
		Fish	The state of the s	Data reading:	s shown as pH va	gauge cha	rts,

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Field testing of the Prawn Growth Model in the real pond

Analysis of different types of object detection model for giant freshwater prawn in turbid and murky water

• YOLOv8 provides the best result combining both processing speed and accuracy

Biomass comparison between YOLO length detection and manual measurements

- Conducted statistical analysis (t-test), found significant difference (p < 0.05) between the two measurements. The values in YOLO are higher than the manual reading.
- Need to refine the size through segmentation for a more accurate length measurement.







 TABLE I.
 COMPARISON RESULTS ON DIFFERENT MODEL

 ARCHITECTURES INCLUDING ITS INPUT SIZE, INFERENCE TIME, MAP UNDER
 0.5:0.95 THRESHOLD, AND MODEL SIZE

Model	Input	Inference	mAP.@	Model Size
	Size	Time (ms)	0.5:0.95	
SSD MobileNet	640x640	124.2	78.66 %	48.3 MB
V1 FPN 640x640				
SSD MobileNet	320x320	80.2	60.53 %	28.3 MB
V2 320x320				
SSD MobileNet	320x320	96.2	78.22 %	17.4 MB
V2 FPNLite				
320x320				
SSD MobileNet	640x640	101.4	77.37 %	17.4 MB
V2 FPNLite				
640x640				
EfficientDet D0	512x512	195.4	73.72 %	40.6 MB
EfficientDet D1	640x640	209.6	61.92 %	50.4 MB
EfficientDet D2	768x768	323.6	36.10 %	65.8 MB
Faster R-CNN	640x640	516.4	47.92 %	117.9 MB
ResNet50 V1				
640x640				
Faster R-CNN	640x640	742.6	33.89 %	198.3 MB
ResNet101 V1				
640x640				
Faster R-CNN	640x640	794.8	36.83 %	264.8 MB
ResNet152 V1				
640x640				
Faster R-CNN	640x640	601.3	53.26 %	252.3 MB
Inception ResNet				
V2 640x640				
YOLOv8	640x640	32.9	83.71%	103.7 MB



Fig. 3. High turbidity underwater freshwater prawn detection result using YOLOv8, with a confidence score of 87%



Fig. 4. High turbidity underwater freshwater prawn detection result using YOLOv8, with a confidence score of 94%



Improving the length and width prediction using Segmentation

The goal of the detection is to detect the length of the prawn from the tip of the head (rostrum) to the tip of the telson (tail) while the width is from the carapace width, so all the dataset masks information images annotated all parts of the prawns accept the legs

Method 1:

YOLOv8 segmentation model for the prawn detection and then get the prawn segmentation, Method 2:

YOLOv8 object detection model to create the bounding box of the prawns detected, which will then be used as a box prompt for SAM to get the prawn segmentation





MEAN AND ERROR VALUES BETWEEN ACTUAL, PREDICTED AND CORRECTED VALUES BASED ON YOLO AND SAM MODELS OF PRAWN MEASUREMENTS. *ASTERISKS INDICATE SIGNIFICANT DIFFERENCES WITH THE ACTUAL VALUES AT P ; 0.05 USING T-TEST AND KS-TEST.

	Actual values	Predicted-YOLO values	Corrected-YOLO values	Predicted-SAM values	Corrected-SAM values				
Length measurement									
Mean length (cm)	15.7	20.5*	15.8	20.8*	16.0				
Mean absolute error (cm)		4.72	0.93	5.00	1.10				
Error percentage (%)		30.2	5.79	32.0	6.97				
Width measurement									
Mean width (cm)	2.71	4.1*	3.16*	4.50*	3.47*				
Mean absolute error (cm)		1.39	0.48	1.79	0.78				
Error percentage (%)		51.6	17.7	66.4	28.8				

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Length accuracy testing at fixed height range of 45 cm – 50 cm between camera and head of prawn

Analysis on the prawn length accuracy at different fixed camera height position

- This method does not require reference code/point
- Based on a fixed focal distance between camera and prawn.
- Calibration of the camera







Focal distance between camera and prawn (cm)

Height distance (cm)	45	46	47	48	<mark>*49</mark>	50	
Actual length	14.70						
Mean length (cm)	13.32	13.88	14.12	14.44	14.74	15.03	
RMSE (cm)	1.51	0.86	0.65	0.36	0.29	0.44	
Mean Absolute Error (cm)	1.38	0.83	0.59	0.30	0.22	0.39	
% Error	9.36	5.62	3.99	2.06	1.53	2.65	
% Accuracy	90.6	94.4	96.0	97.9	98.5	97.4	

*at height distance of 49cm, there are no significant differences between the actual length of prawns and the predicted values, with the error value of 0.2cm at 98.5% accuracy





Scientific Contribution:

No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
1	Analysis of Deep Learning Algorithms for Prawn Aquaculture in a Challenging Environment	Wafiq Zariful, Najeebah Az-Zahra Tashim, Tiong Hoo Lim, Aida Maryam Basri, Suriayati Chuprat, Seno Adi Putra, Hanif Fakhrurroja and Pengcheng Liu	Universiti Teknologi Brunei, Universiti Teknologi Malaysia, Telkom University Indonesia, National Research and Innovation Agency Indonesia, University of York	The 6th International Conference on Applied Computational Intelligence in Information Systems	25/10/2023	International Conventional Centre, Brunei Darussalam
2	Nutritional Quality of Cultured Giant Freshwater Prawns (<i>Macrobrachium</i> <i>rosenbergii</i>)	Nurul Fithriyani Mohamad Saifol Rizal, Najeebah Az-Zahra Tashim, Zuhairi Azahari, Aida Maryam Basri, Tiong Hoo Lim, Aqilah Junaidi, Suriayati Chuprat, Seno Adi Putra and Hanif Fakhrurroja	Universiti Teknologi Brunei, ODE Aquaculture and Agriculture Farm, Department of Fisheries Ministry of Primary Resources and Tourism Brunei, Universiti Teknologi Malaysia, Telkom University Indonesia, National Research and Innovation Agency Indonesia	International Conference on Agrotechnology, Beverage and Food (ICABF 2023)	25/10/2023	International Conventional Centre, Brunei Darussalam
3	Comparison of Biocode Based Machine Learning and Segmentation Model for Automated Prawn Size Prediction for Real Prawn Farm	Muhammad Wafiq Abd Zariful Najeebah Az-Zahra Tashim, Tiong Hoo Lim, Hanif Fakhrurroja, Suriayati Chuprat, Seno Adi Putra, Pengcheng Liu, Aida Maryam Basri	Universiti Teknologi Brunei, Universiti Teknologi Malaysia, Telkom University Indonesia, National Research and Innovation Agency Indonesia, University of York	2024 Asia-Pacific Conference on Image Processing, Electronics and Computers (IPEC)	13/04/2024	Dalian, China

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Research and Development:

- YOLOv8 provides the best result combining both processing speed and accuracy
- Deploying segmentation for more accurate measurement
- Regression based Biomass prediction for Weight and Length Relationship
- Nutrition Analysis of Giant Prawn
- Aiquatic App for Prawn Monitoring



- 1. Distance based Biomass predictor
- 2. Alquatic Autofeeder
- 3. Underwater Drone Development and Deployment
- 4. Fish App
- 5. Commercialization (grant supported by UNDP)