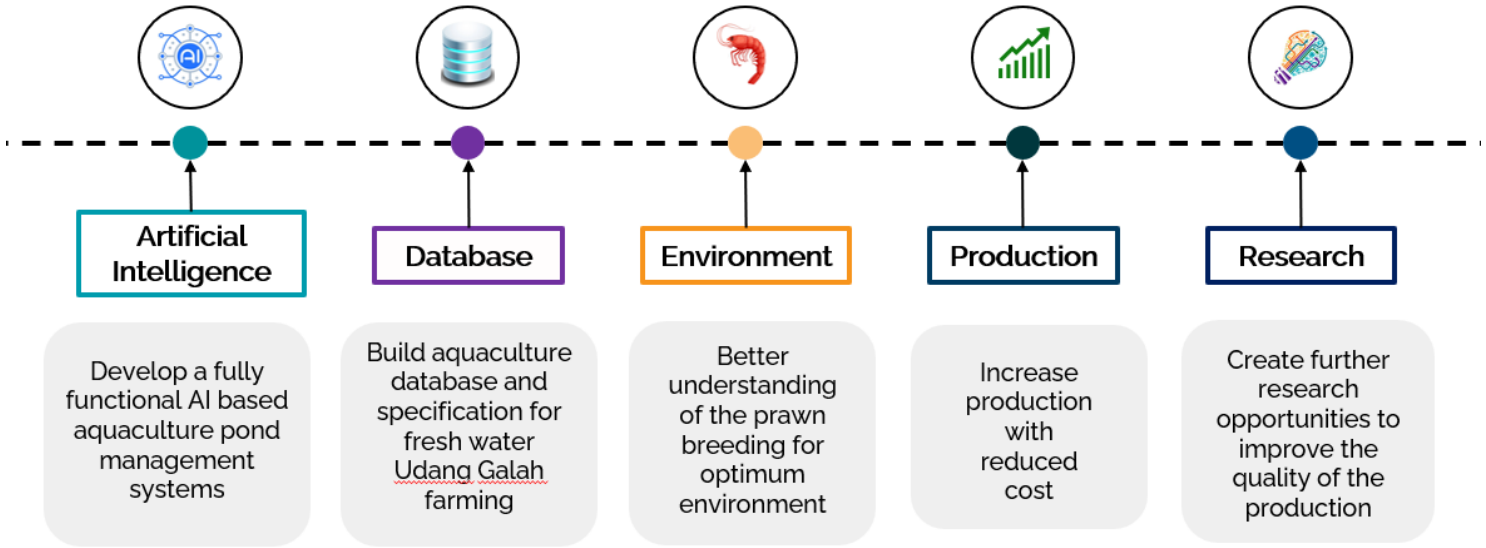
Project Title: AI-Based Real time analysis and control of the monitoring on the growth of Freshwater prawn using video image processing from underwater drone

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

Targets:



Speaker: **Tiong Hoo Lim (UTB, Brunei)**

Project Title: AI-Based Real time analysis and control of the monitoring on the growth of Freshwater prawn using video image processing from underwater drone

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)

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)

Project Duration :

12 Months – Extended 12 months (24 Months)

Project Budget:

USD $38,100

Project Activities: (Max. 5 slides)

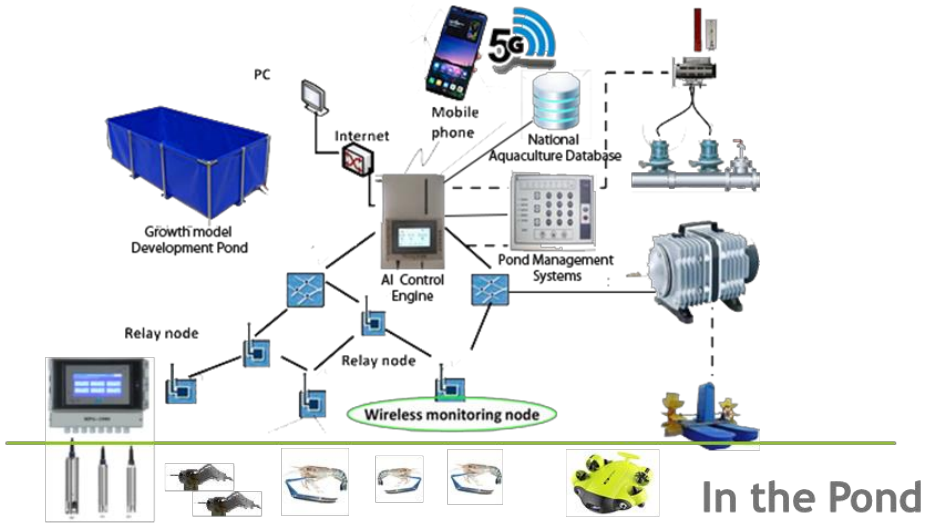
INPUT

Industrial Based Sensor

Underwater video imaging camera

Systems Development Process

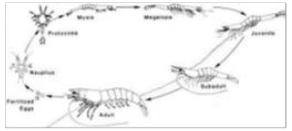
IoT Agro-system Deployment	Water Quality Analysis	AI Growth Model Development	Growth Environment Optimisation



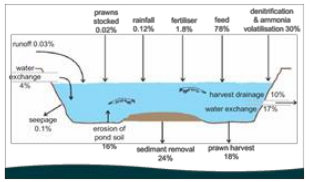
In the Pond

OUTPUT

Growth Monitoring



Growth Database



Automated Control Breeding Environment

- 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)

Project Activities:

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).

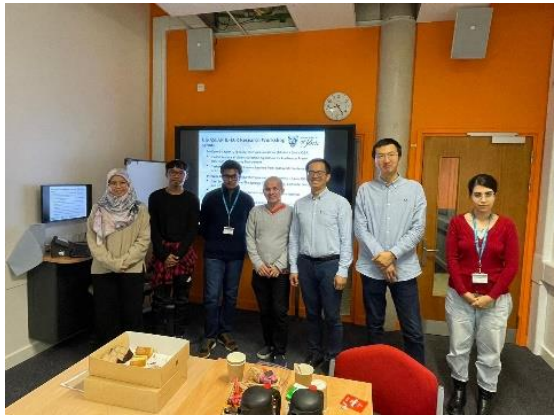
Stakeholder information sharing

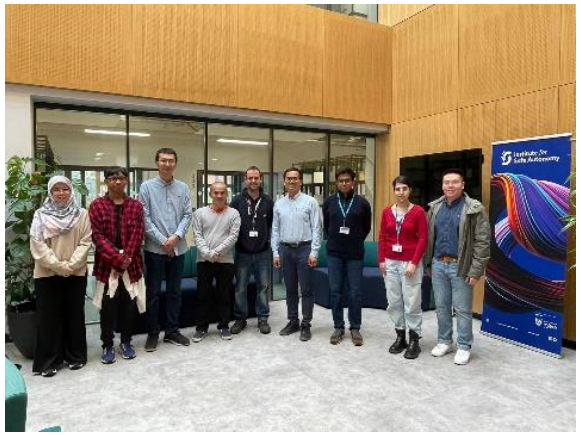
- Mr Zuhairi Hj Azahari (ODE, Aquaculture and Agriculture Company, Brunei) – Access to the pond
- Dr Aqilah Junaidi (Fisheries Department, Ministry of Primary Resource and Tourism, Brunei) – Expert advice on the current breeding environment

Project Activities:

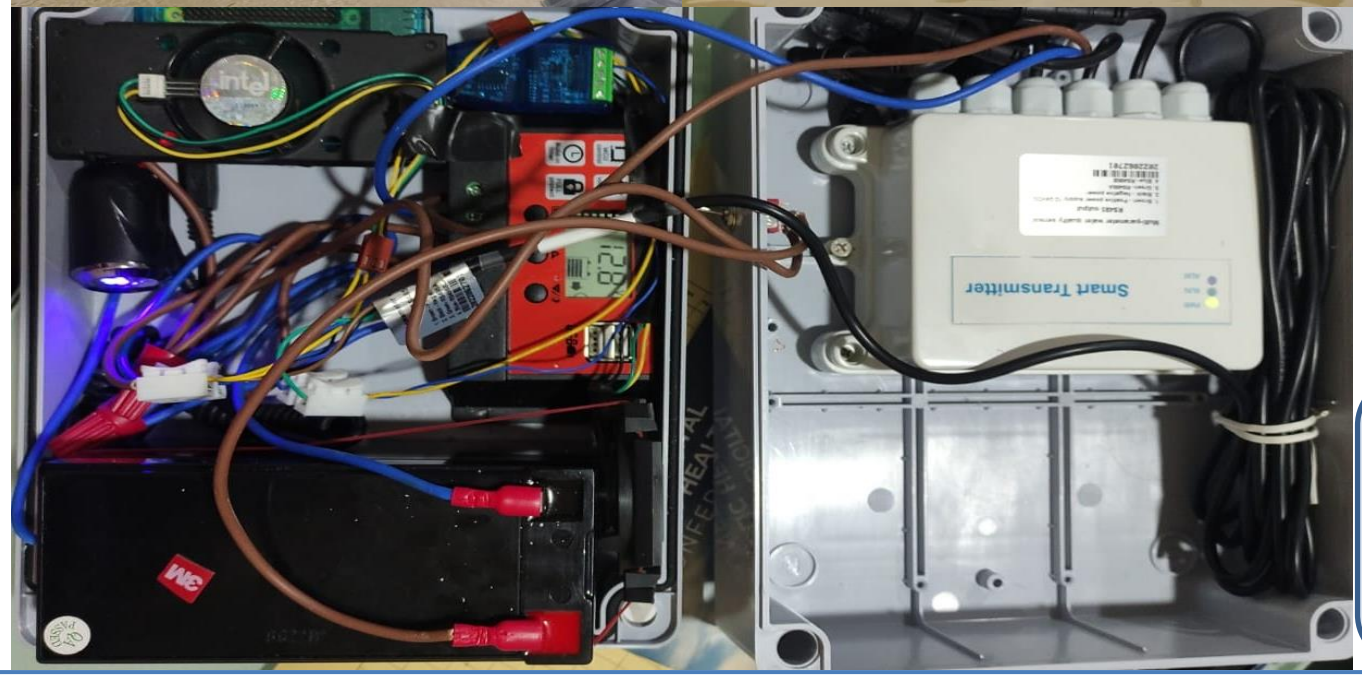
Research Visit to Telkom University and BRIN, Indonesia 2023

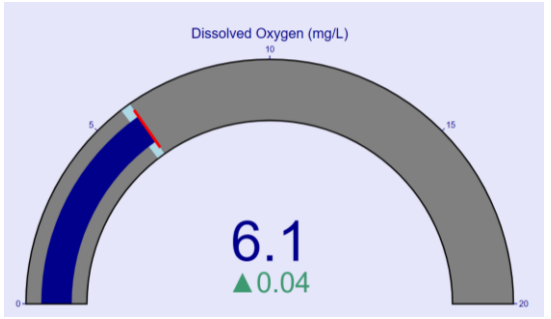
Research Visit to University of York, UK 2023

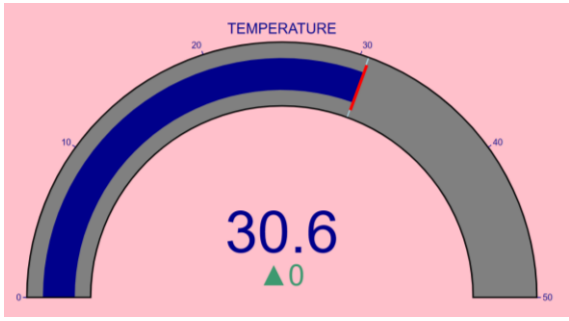


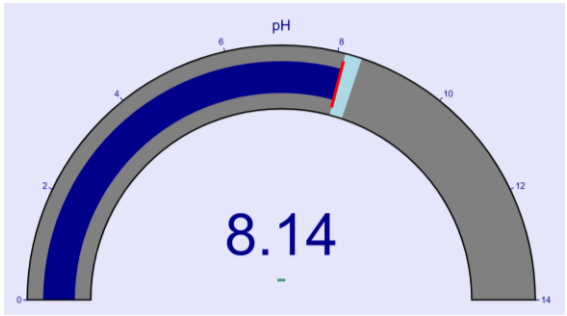


Project Activities: Solar Powered IoT Water Quality Monitoring

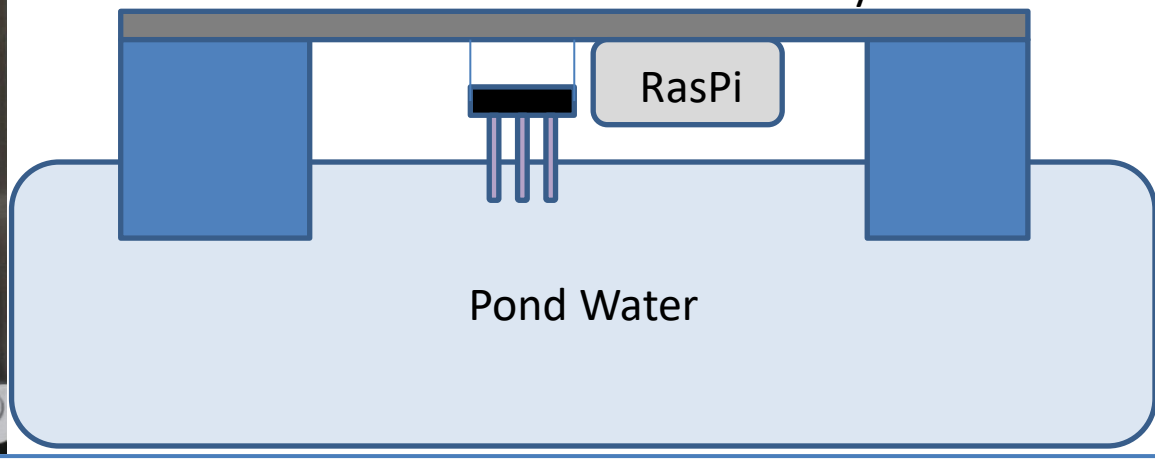




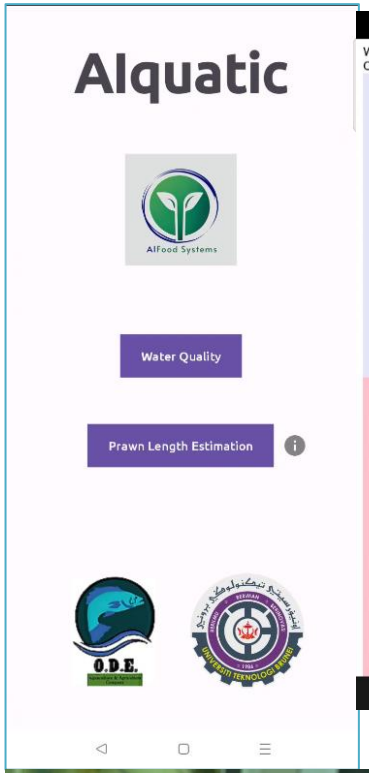


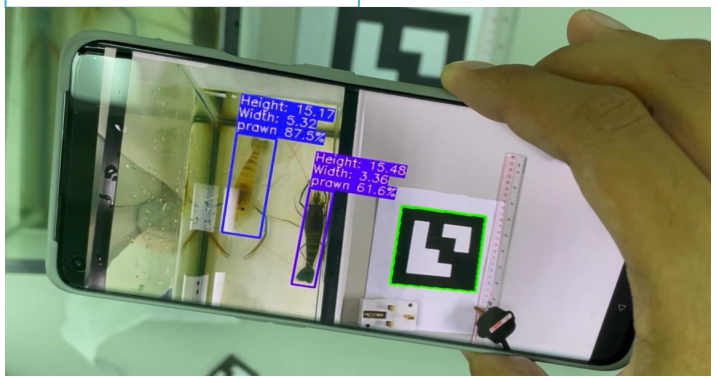


Solar Panel with 12V battery



Project Activities: Alquatic





Alquatic

Select Role:

Farmer

User

Fish

Alquatic

Water Quality

Weather Station

Prawn Biomass Estimation

min	1.01		29.7
25%	1.27	0	29.9
50%	1.54	0	30.4
75%	1.84	0	30.9
max	2.19	0	31.3

Date & Time	Ammonia	Dissolved Oxygen	Temperature	p
2024-10-21 12:20	0	1.47	30.1	
2024-10-21 12:15	0	1.28	30.1	
2024-10-21 12:10	0	1.49	30.1	
2024-10-21 12:05	0	1.93	30.1	
2024-10-21 12:00	0	2.13	30	
2024-10-21 11:55	0	1.41	30	
2024-10-21 11:45	0	2.08	30	
2024-10-21 11:40	0	1.46	30	
2024-10-21 11:35	0	1.4	30	
2024-10-21 11:30	0	1.32	30	

« ‹ 1 / 26 › »

Data readings shown as gauge charts.

pH value.

R&D results: (Max. 3 slides)

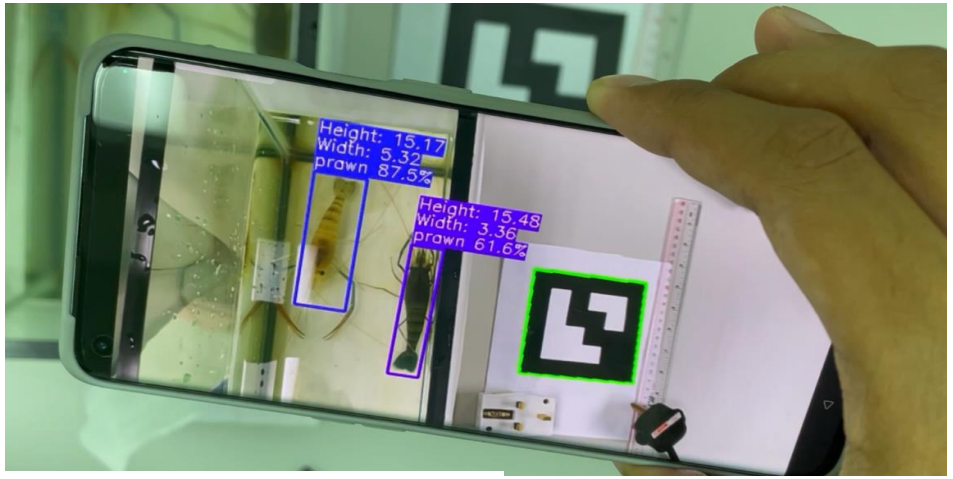
Field testing of the Prawn Growth Model in the real pond

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.



Manual (cm)	App/YOLO/length (cm)	Image from App
13	13.20	
12	15.30	

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 Size	Inference Time (ms)	mAP @ 0.5:0.95	Model Size
SSD MobileNet V1 FPN 640x640	640x640	124.2	78.66 %	48.3 MB
SSD MobileNet V2 320x320	320x320	80.2	60.53 %	28.3 MB
SSD MobileNet V2 FPNLite 320x320	320x320	96.2	78.22 %	17.4 MB
SSD MobileNet V2 FPNLite 640x640	640x640	101.4	77.37 %	17.4 MB
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 ResNet50 V1 640x640	640x640	516.4	47.92 %	117.9 MB
Faster R-CNN ResNet101 V1 640x640	640x640	742.6	33.89 %	198.3 MB
Faster R-CNN ResNet152 V1 640x640	640x640	794.8	36.83 %	264.8 MB
Faster R-CNN Inception ResNet V2 640x640	640x640	601.3	53.26 %	252.3 MB
YOLOv8	640x640	32.9	83.71%	103.7 MB

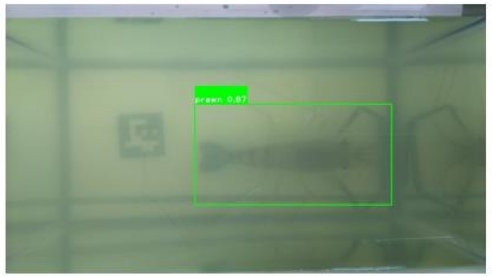


Fig. 3. High turbidity underwater freshwater prawn detection result using YOLOv8, with a confidence score of 87%

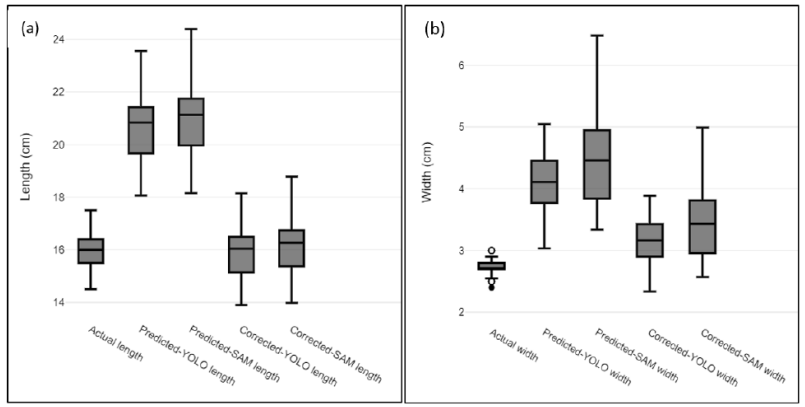
Fig. 4. High turbidity underwater freshwater prawn detection result using YOLOv8, with a confidence score of 94%

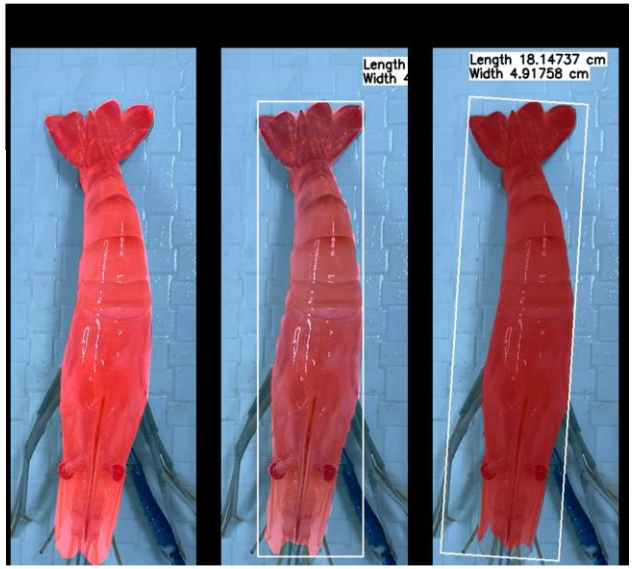
R&D results: (Max. 3 slides)

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.

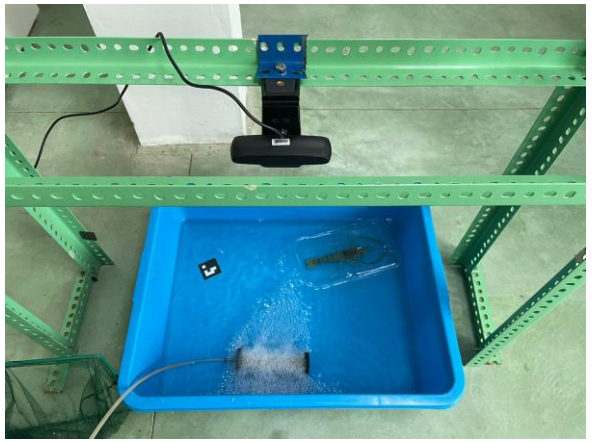
	Actual values	Predicted-YOLO values	Corrected-YOLO values	Predicted-SAM values	Corrected-SAM values
Length measurement					
Mean length (cm)	15.7	20.5*	15.8	20.8*	16.0
Mean absolute error (cm)		4.72	0.93	5.00	1.10
Error percentage (%)		30.2	5.79	32.0	6.97
Width measurement					
Mean width (cm)	2.71	4.1*	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

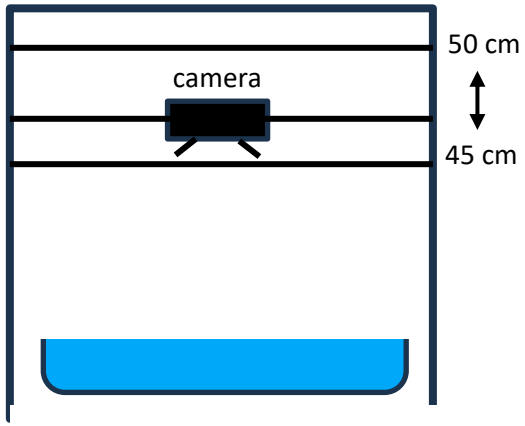
R&D results: (Max. 3 slides)

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

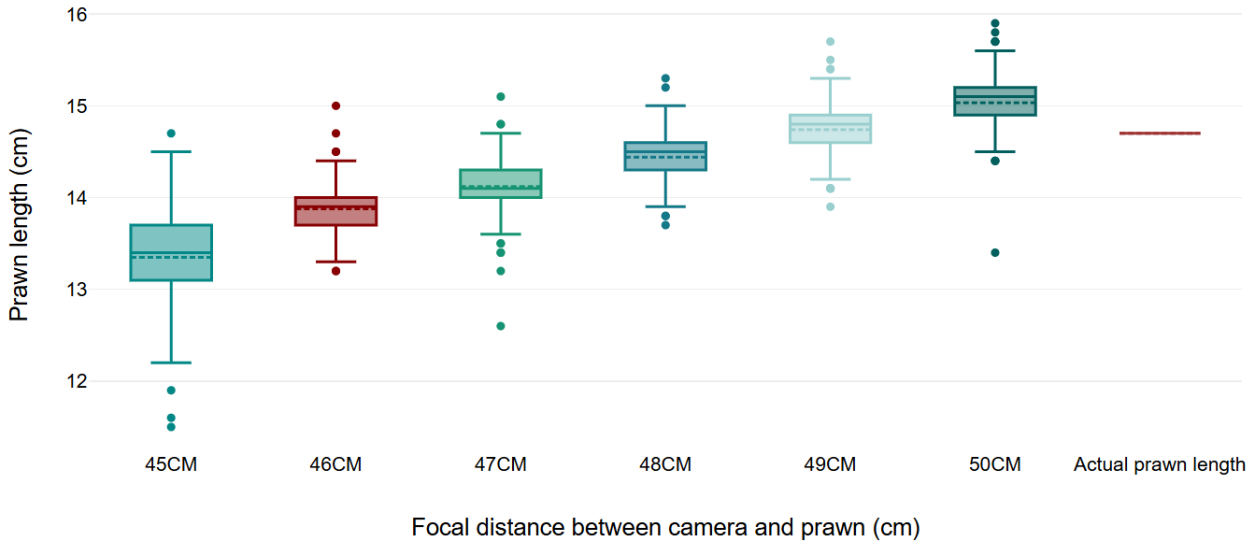
Analysis on the prawn length accuracy at different fixed camera height position

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





Side view



Height distance (cm)	45	46	47	48	*49	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

R&D results: (Max. 3 slides)

Alquatic App Promotional Video

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 (*Macrobrachium rosenbergii)*	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

Societal Impact:

- **Improve farm management and water treatment.**
- Better working environment.
- Support green and blue Aquaculture.

Optimum & Economical Breeding

- **Reduce growth time from 5 to 4 months.#**
- **Increase survival rate by 20%.#**
- Reduce wastage on feed.

- **Increase Aqua-tech activities.**
- Create new job opportunities.
- Attract investment.
- Encourage Agro-business.

New Opportunities

Economical Benefit

- **Increase productions (from 7980 kg to 9576 kg).***
- **Lower operation costs.**
- Increase ODE contribution to Brunei freshwater prawn production to **44.7%.***

Goal 2 | Goal 3 | Goal 3 | Goal 1 | Goal 2 | Goal 1

Brunei Wawasan 2035

- **Generate new knowledge.**
- Improve aquafarm methods.
- Identify best practices.
- Provide innovative farming.

Knowledge Transfer

Social Benefit

- **Address food security through sustainable aquaculture.**
- Improve socio-economic independence.
- Provide source of protein.

Digital Wealth

- **Sharing of Aqua-cloud with farmers.**
- Digitalization and Agro-data analytics.

- **IR-4.0 Ready Aquaculture systems.**
- Technology transfer to new industry.

Conclusion:

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

Future works:

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