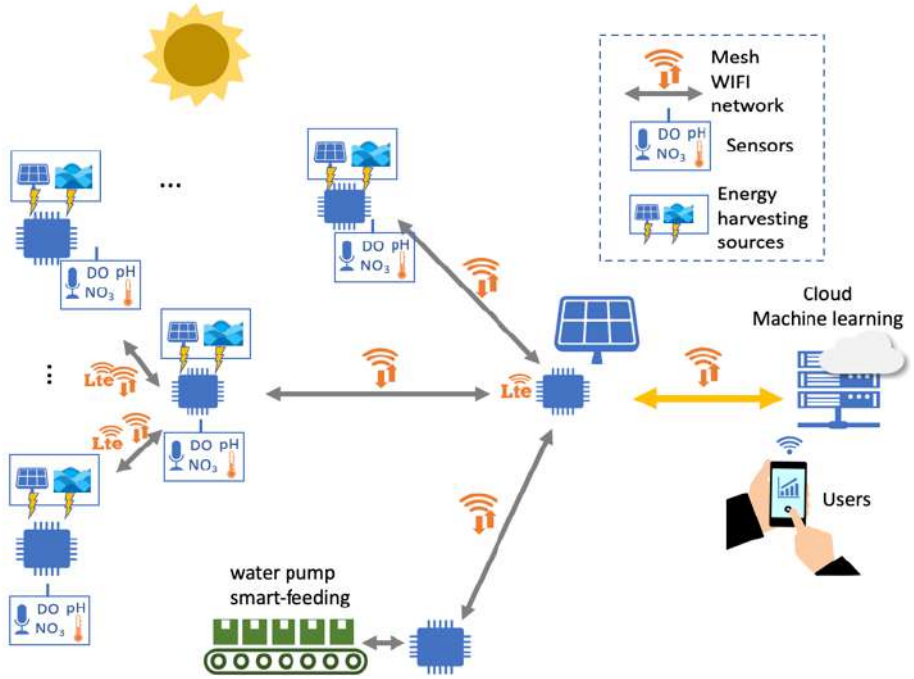
Project Title: **Resilient AIoT Green Energy System with Real-time Solution for Effective Aquaculture (REAS-SEA)**

Background :

- Current ***global climate change*** together with a series of upstream dams placed by China on the Mekong River
- Adoption of shrimp farming is a potential and ***natural solution*** for traditional farmers

Targets :

- **To support** Southeast Asia and Vietnam's fast growth aquaculture industry with a real-time and holistic control solution
- **To help** farmers optimize their feeding pattern for growth, controlling dissolved oxygen, chemical and antibiotic use, reducing water pollution and mortality rate and feed cost.



Speaker: **Tran Thi My Hanh, Nha Trang University, Vietnam (Project leader)**

Project Title: **Resilient AIoT Green Energy System with Real-time Solution for Effective Aquaculture (REAS-SEA)**

Project Members :

Party	Name	Division
PTIT, Vietnam	*Vo Nguyen Quoc Bao	Faculty of Telecommunications
UTokyo, Japan	*Nguyen Ngoc Mai Khanh	Systems Design Lab (d.lab), Japan
SOITEC, Singapore	*Nguyen Bich Yen	Innovation
NTU, Vietnam	***Tran Thi My Hanh**	Department of Research Affairs
	Nguyen Tan Sy	Institute of Aquaculture
	Ngo Van Manh	Institute of Aquaculture
IICT, Laos	Sayfon BOUTCHANTHALATH	Director General, Institute of Information and Communication Technology
	*Padapxay SAYAKHOT	Deputy Director General, Institute of Information and Communication Technology
	Aromhack SAYSANASONGKHAM	Deputy Director, Planning, Cooperation and Finance Division
	Phonexay NAMSAVANH	Technical Officer, Institute of Information and Communication Technology
	Phuangkeo KEOPHENGTHONG	Technical Officer, Institute of Information and Communication Technology
MMU, Malaysia	*Foo Yee Loo	Faculty of Engineering
BLU, Vietnam	*Luu Ngo Duc	Faculty of Information Technology
	Nguyen Thi Hong Van	Faculty of Aquaculture
LEO, Japan	*SATOSHI YOSHINO	R&D Division
CADT, Cambodia	* Sopheakmanith Chhoun	Research & Innovation Center
	Chin Vannak	Research & Innovation Center
	Kann Bonpagna	Research & Innovation Center

Project Duration :

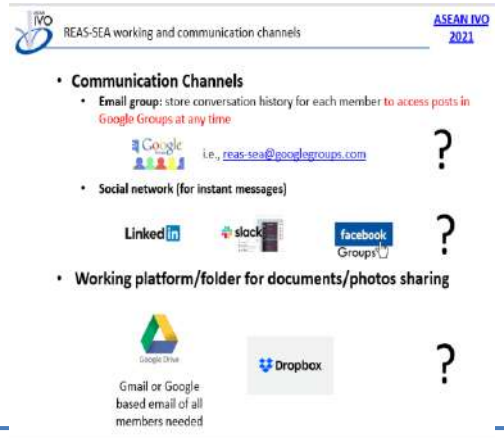
- First year: April 1st, 2021 – March 31st, 2022
- Second year: April 1st, 2022 – Mar 31st, 2023
- Third year: April 1st, 2023 – Mar 31st, 2024

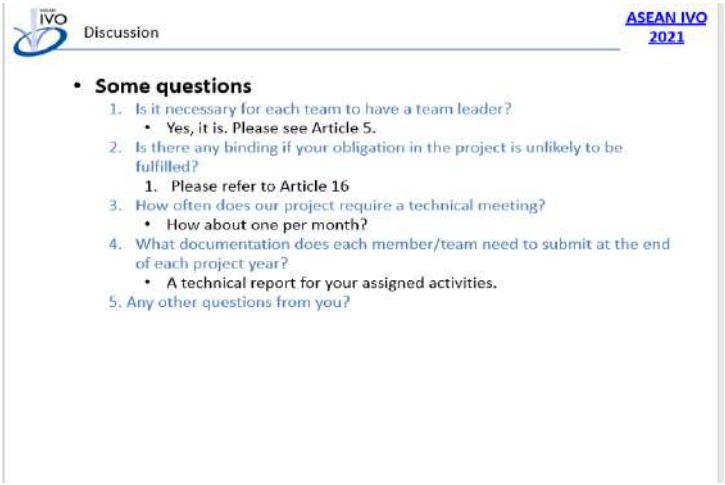
Project Budget: 80,000 USD

Project Activities #1: **REAS-SEA Kick-Off Meeting**

Time: June 15, 2021
Place: online by Google meet
https://meet.google.com/rza-pfcy-qwr
Attendance: All members
Agenda:

- Short introduction of members (1 minute for each with your slide): ~15 minutes
- Overview and plan: 10 minutes
- Other procedures and information
- CRDA
- Shared drive & communication tool/channel: 10 minutes
- Discussion: 10 minutes
- Group photos in Google meet and closing: 5 minutes

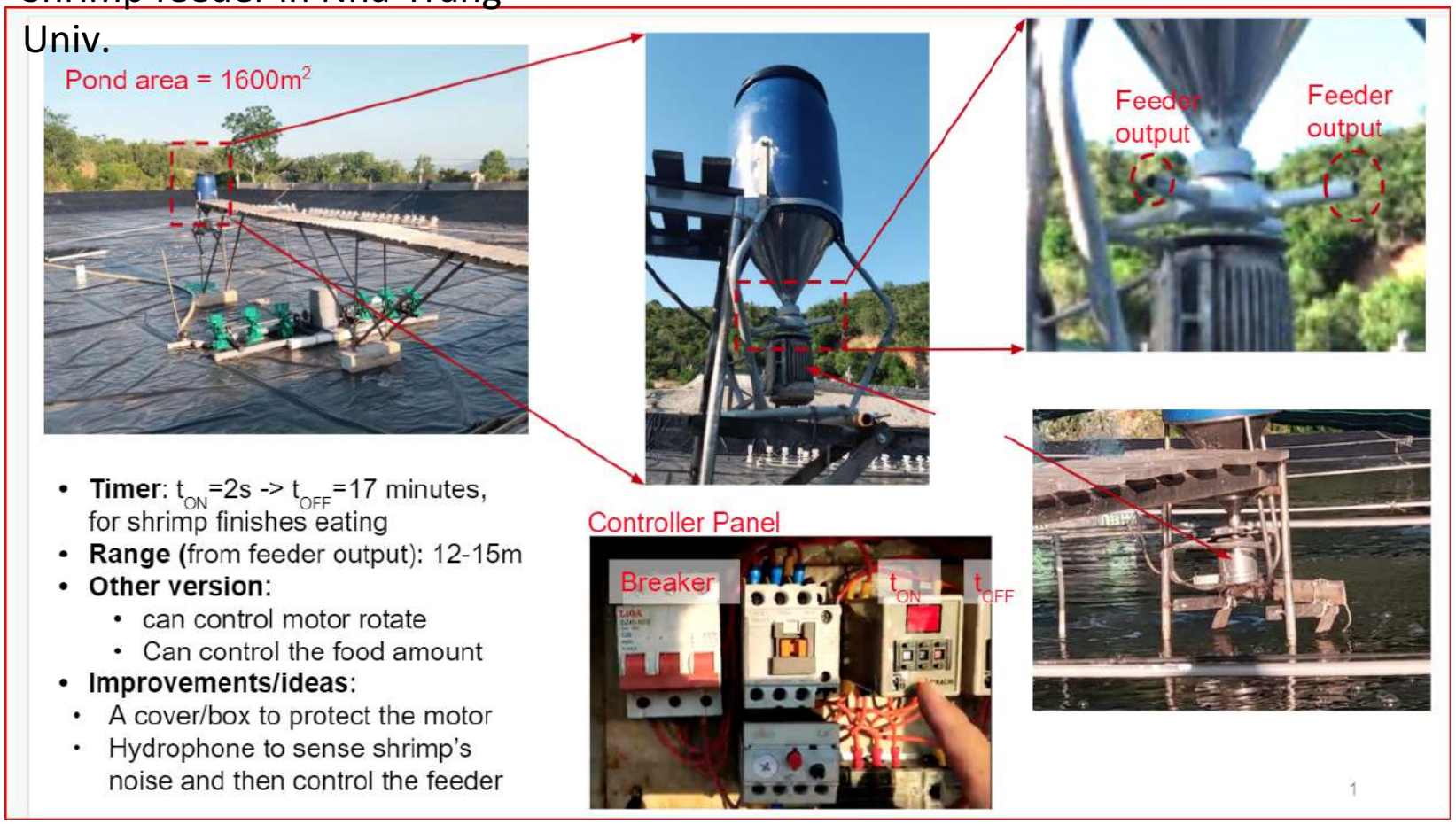




Project Activities #2: Meetings with **LEO**

Discussion on shrimp feeder with sensors

Shrimp feeder in Nha-Trang Univ.



Project Activities #3:

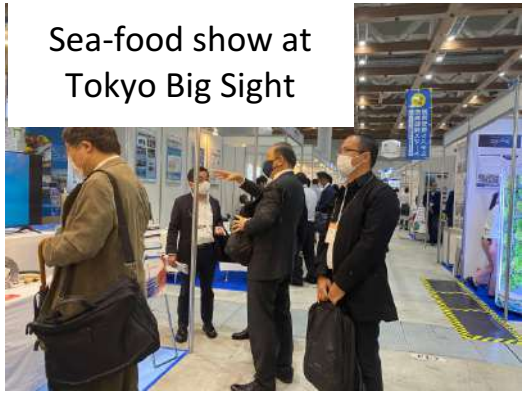
- **Propose and host** a Special Session entitled “Advanced Communication and Signal Processing Technologies for IoT-based Smart Farming” at IEEE Nafosted NICS conference
- **Visit** seafood show in Tokyo, Japan
- Design two **experiments** (indoor & outdoor) for recording **shrimp noise** in Nha-Trang Univ.

NICS 2021
Hanoi, Vietnam, Dec 21-22, 2021

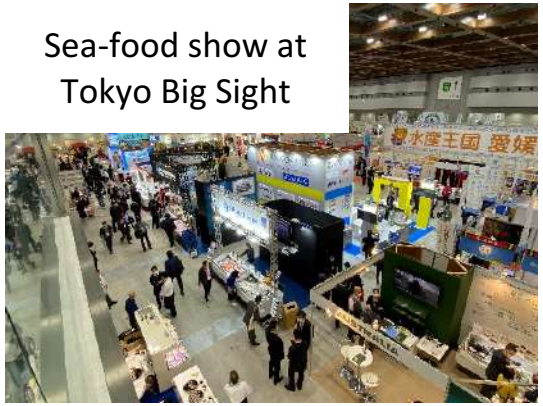
Circular Pond: Area 100-800m^2

NTU, Vietnam

Sea-food show at Tokyo Big Sight



Sea-food show at Tokyo Big Sight



Location for collecting samples

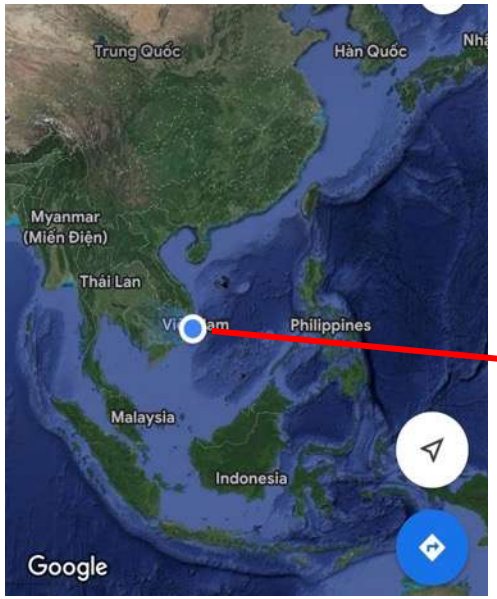
Feeder

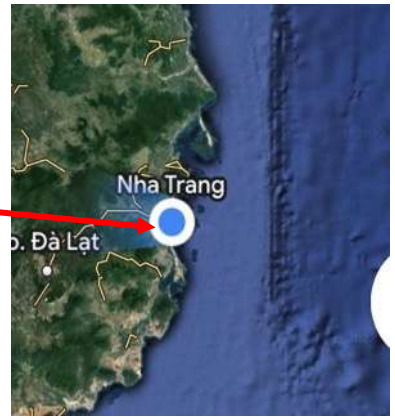
Underwater Camera

Project Activities #4: Work with Rector of Nha Trang University and Reseacher Team

Time: Apr. 20, 2022
Place: NhaTrang University, Khanh Hoa Province, Vietnam
Members:

- LEO Electronics, Japan
- NhaTrang University, Vietnam
- UTokyo, Japan
- Soitec-Singapore





Project Activities #5: Visit LEO Electronics Vietnam

Time: Apr. 18, 2022
Place: Hai Duong, Vietnam
Members:

- LEO Electronics, Japan
- NhaTrang University, Vietnam
- UTokyo, Japan

Project Activities #6: Visit Chinh-My Shrimp Farm, Khanh-Hoa Province, Vietnam

Time: Apr. 2022
Place: Khanh-Hoa, Vietnam
Members:

- NhaTrang University, Vietnam
- Soitec, Singapore
- LEO Electronics, Japan
- UTokyo, Japan







Project Activities #7: NTU Aquaculture lab, NhaTrang Univ., Vietnam

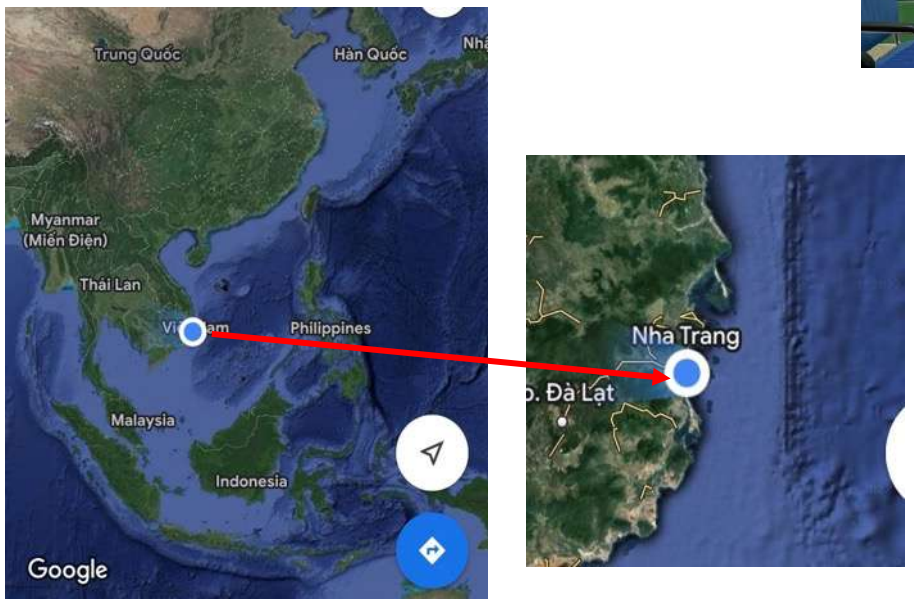
Time: Apr. 21 2022
Place: Cam Ranh, Vietnam
Members:

- NhaTrang University, Vietnam
- Soitec, Singapore
- LEO Electronics, Japan
- UTokyo, Japan

Project Activities #8: Face to face meeting at Nha Trang University, Vietnam

Time: September 14, 15. 2023
Place: Nha Trang University, Khanh Hoa Province, Vietnam
Members:

- NTU, Vietnam
- Soitec-Singapore
- IICT, Laos
- CADT, Cambodia
- UTokyo, Japan (online)
- MMU, Malaysia (online)



Project Activities #9: NTU Aquaculture lab, NhaTrang Univ., Vietnam

Time: Sept. 15 2023
Place: Cam Ranh, Vietnam
Members:

- NTU, Vietnam
- Soitec-Singapore
- IICT, Laos
- CADT, Cambodia

Project Activities #10: Face to face meeting at Bac Lieu University, Vietnam

Time: March 27&28. 2024
Place: Bac Lieu University, , Vietnam
Members:

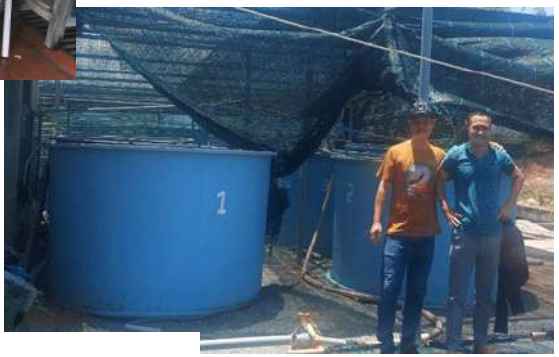
- NTU, Vietnam
- BLU, Vietnam
- UTokyo, Japan
- Soitec-Singapore (online)
- IICT, Laos (online)
- CADT, Cambodia (online)
- MMU, Malaysia (online)

Project Activities: **Indoor and outdoor experiment**

Content 1: Experiment indoor

1.1. Recording sound of shrimp at different nutritional status (hungry state, average eating state, satiation stage) in anechoic chamber and normal tanks (8m)

1.2. Measure environmental parameters (pH; DO, temperature; Total Ammonia) use automatic sensor.



Content 2: Experiment outdoor (Field trip)

2.1 Shrimp sound Recording in pond.

2.2 Test environment parameters in shrimp pond (pH; temperature; DO; TAN) by automatic sensor.

2.3 Trail feeder machine.

2.4 Use underwater Camera to check shrimp feeding.

Result : Measure environment parameters in tanks

Second step:

Time: Apr to June -2023

- **Total tanks**: 03 tanks

Volume 8 m^3/tank.

- **Density**: 200 con/m^2
- **Time for trail**: 30 - 60 days.
- **Environment parameters :** DO; pH; ORP
- **Measure Device:** ASIA

Result : Environment outdoor

Measure Device:

ASIA IVO.

Environment parameters:

DO; pH; temperature; ORP

Pond Systerm:

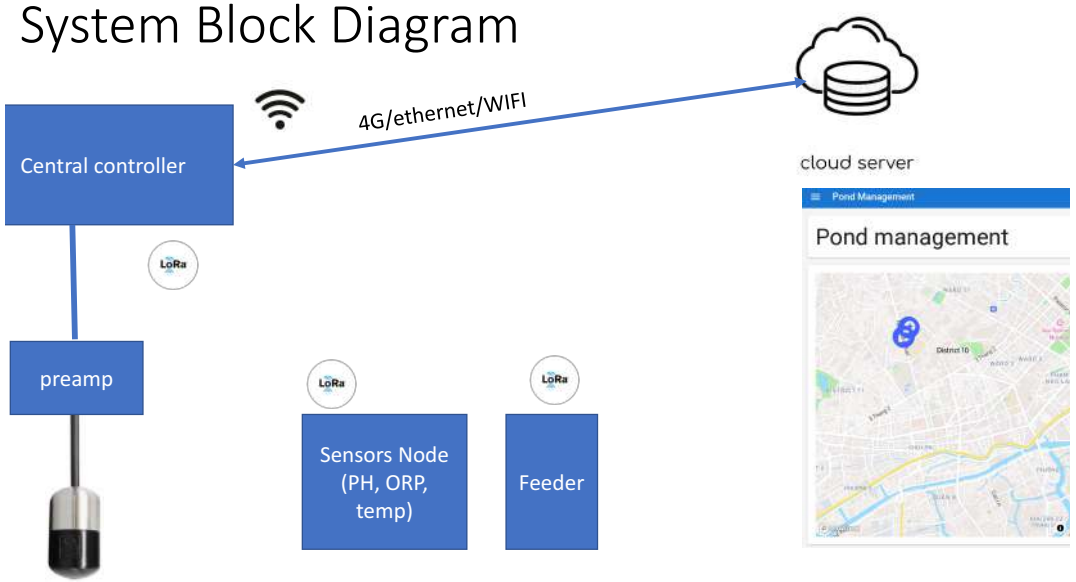
2 ponds; Size 200m/pond.

Time:

From June to Oct – 2023.

R&D results: Shrimp Pond Data Acquisition System

System Block Diagram



Phase 1: 4/2023

- Focus on indoor monitoring
- Monitored PH, ORP and temperature

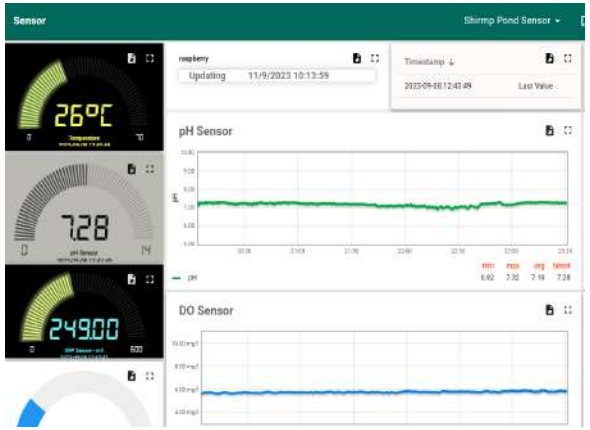
- Connection is unstable after 1 week → change the communication module
- PH, ORP and temperature value was stable in door

Phase 2: 7/2023

- Outdoor Monitoring
- Monitored PH, DO and temperature
- Record shrimp sound in door

R&D results: Shrimp Pond Data Acquisition System

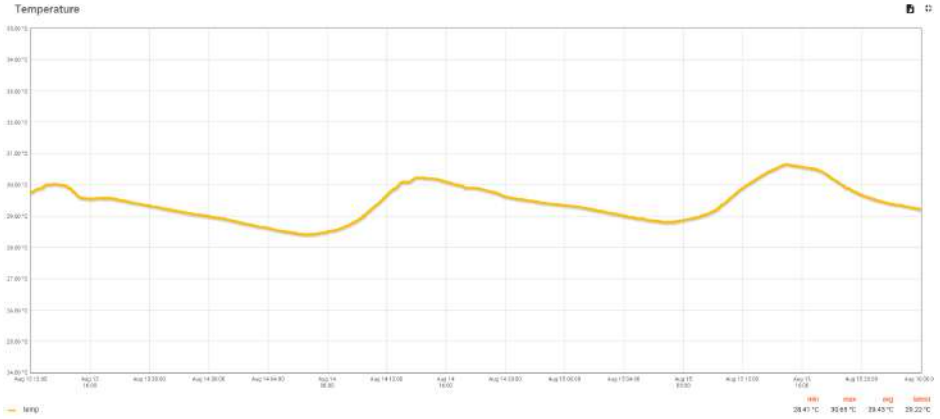
Outdoor Water Quality Monitoring System



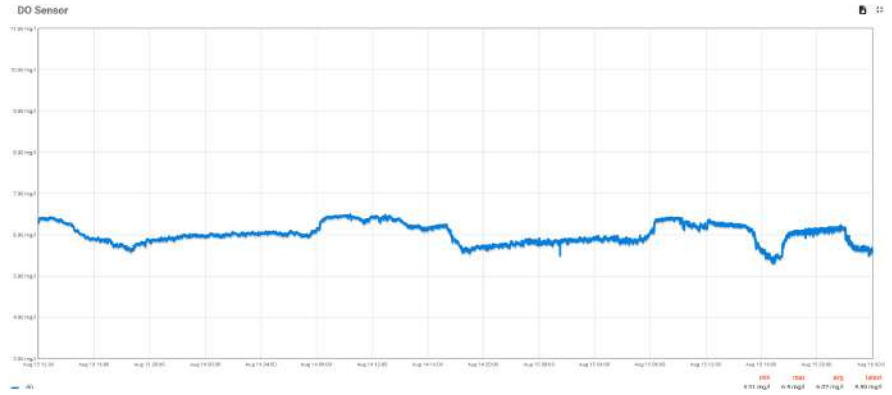
Sensors and measurement node

DO	RK500-04
PH	HAOSHI H-101
Temp	PT100

Water temperature chart

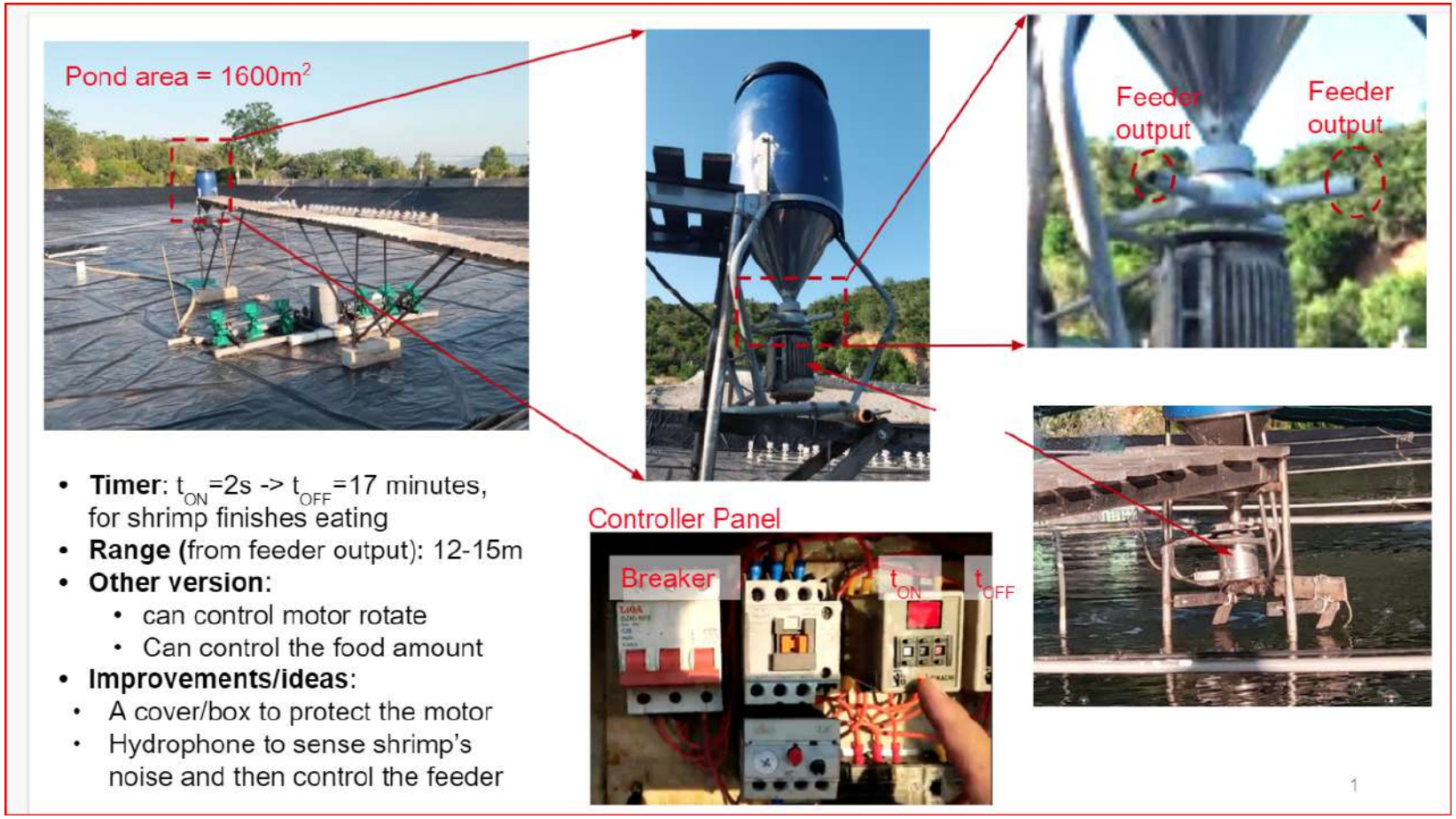


DO chart



Project results: Design and testing shrimp feeder

The conventional Shrimp feeder in Nha-Trang Univ.



- **Timer**: t_{ON}=2s -> t_{OFF}=17 minutes, for shrimp finishes eating
- **Range (**from feeder output): 12-15m
- **Other version**:
  - can control motor rotate
  - Can control the food amount
- **Improvements/ideas**:
  - A cover/box to protect the motor
  - Hydrophone to sense shrimp's noise and then control the feeder

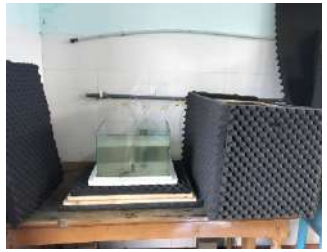
The proposed shrimp feeder: filed test with shrimp foods

Project result: Shrimp sound recording and analyzing

Sound collection and Algorithms

Task #1: Shrimp sound recording

Case #1 (ideal): Soundproof box



Case #2 (practical): Shrimp farm

Measure and Observe

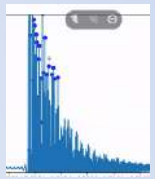
Waterproof camera to obverse shrimp behaviors

Sony: D10 Linear PCM-Recorder D Series

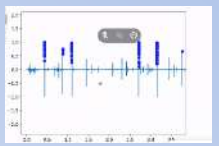
Sony sound amplifier

Task #2: Shrimp sound analyzing

Shrimp sounds



Separating shrimp sounds from real farm noise and Interference



Classifying the shrimp sounds to 5 levels

Principal Component Analysis (PCA)

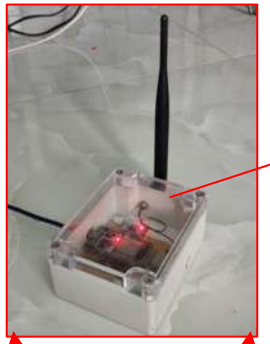
Artificial Intelligence (AI)

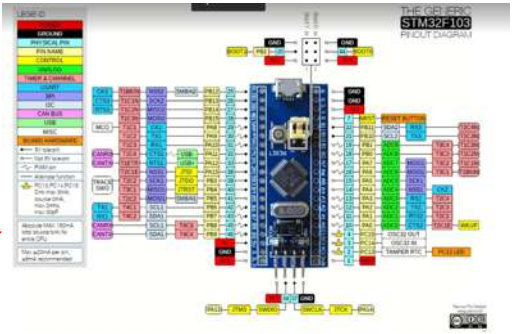
PCA is better than AI

R&D results: Sensing Node Design and Implementation

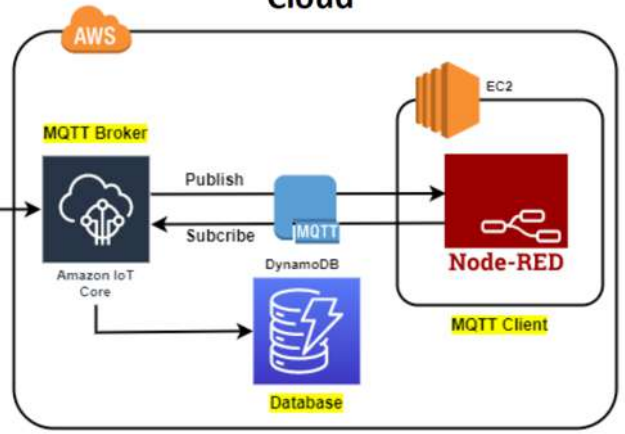
Sensing End Node with Solar

Gateway



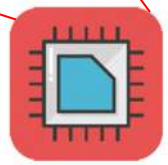


Cloud



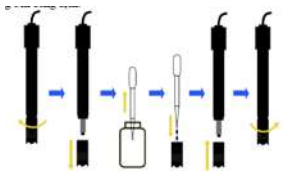
real-time sensing

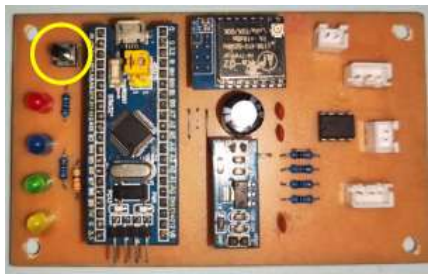
End Node



Gateway

Controlling circuit





Internet

PC/Laptop/Smartphone/Table

Shrimp eating sound recording

- Utilize a hydrophone to record under water sound
- Design a preamp device to amplify the hydrophone output
- Use smartphone to record the sound
- Upload result to cloud storage for later analyzing

Request for sound processing

At least **1000** files:

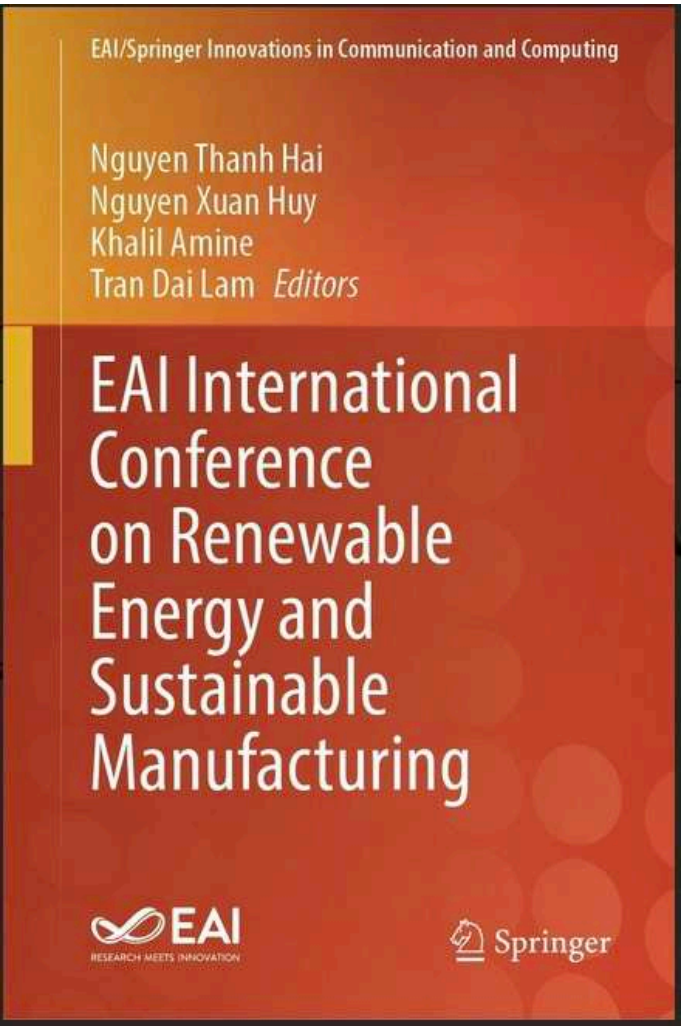
1. **Indoor shrimp only** with **cleaner** quality
2. Specific recordings of **natural shrimp behavior** vs **eating**
3. Recordings of varying **amount** of shrimp.
4. Different **time domain** of eating period
5. **10+** files of **outdoor noises**: **single** and **mixed**

Getty Images/iStockphoto

Scientific Contribution: Presentations at International Conferences

No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
1	Application of sensing and electronic systems for automatic management of environmental factors and diseases in intensive shrimp farming	Nguyen Tan Sy[1], Nguyen Ngoc Mai Khanh[2], Nguyen Thi Bich Yen[3], Nguyen Dinh Huy[1], Bui Quoc Bao[4], Hoang Nguyen[5], Nguyen Thi Kim Cuc[1], Tran Thi My Hanh[1].	[1]Nha Trang University, Vietnam [2]The University of Tokyo, Japan [3]Soitec, France [4]Ho Chi Minh City University of Technology, Vietnam [5]MnM System Designs LLC, United States	Aquaculture Vietnam 2023	11-13/10/2023	Ho chi Minh city, Vietnam
2	Application of sensing and electronic systems for automatic management of environmental factors and diseases in intensive shrimp farming	Nguyen Tan Sy[1], Nguyen Ngoc Mai Khanh[2], Nguyen Thi Bich Yen[3], Nguyen Dinh Huy[1], Bui Quoc Bao[4], Hoang Nguyen[5], Nguyen Thi Kim Cuc[1], Tran Thi My Hanh[1].	[1]Nha Trang University, Vietnam [2]The University of Tokyo, Japan [3]Soitec, France [4]Ho Chi Minh City University of Technology, Vietnam [5]MnM System Designs LLC, United States	Current status and solutions for sustainable development of Ca Mau shrimp industry	12/2023	Ca Mau Province, Vietnam
3	Integrated Monitoring System for Shrimp Farming: Combining Acoustic and Water Quality Analysis	Bao Bui[1], Khanh Nguyen[2], Sy Nguyen[3], Yen Nguyen[4], Hoang Nguyen[5], Huy Nguyen[3], Le Nguyen[3], Binh Nguyen[1], Hung Nguyen[1], Hieu Cao[1], Sang Nguyen[1] and Hanh Tran[6*]	[1]Department of Electronics Ho Chi Minh City University Of Technology (HCMUT), Vietnam [2]Systems Design Lab (d.lab), The University of Tokyo, Japan [3]Institue of Aquaculture, Nha Trang University, Vietnam [4]Soitec, France [5]MnM System Design LLC, United States [6]Department of Science and Technology, Nha Trang University, Vietnam	EAI ICRESM 2023	16-17/12/2023	Ho chi Minh city, Vietnam
4	Some results of “Resilient AIoT Green Energy System with Real-time Solution for Effective Aquaculture ”	Tran Thi My Hanh[1], Nguyen Tan Sy[1], Nguyen Ngoc Mai Khanh[2], Nguyen Thi Bich Yen[3], Nguyen Dinh Huy[1], Bui Quoc Bao[4], Hoang Nguyen[5], Nguyen	[1]Nha Trang University, Vietnam [2]The University of Tokyo, Japan [3]Soitec, France [4]Ho Chi Minh City University of Technology, Vietnam [5]MnM System Designs LLC, United States	Towards green technology for agriculture, forestry and	15-17/8/2024	Can Tho City, Vietnam

Scientific Contribution: Q4 Paper and patent



Integrated Monitoring System for Shrimp Farming: Combining Acoustic and Water Quality Analysis

Bao Bui, Khanh Nguyen, Sy Nguyen, Yen Nguyen, Hoang Nguyen, Huy Nguyen, Le Nguyen, Binh Tran, Hung Nguyen, Hieu Cao, Sang Nguyen, and Hanh Tran

Abstract The aquaculture industry is a cornerstone of Vietnam's economy, with the cultivation of white-leg shrimp (*Penaeus vannamei*) as a significant contributor to its growth. Efficient feeding practices are paramount in optimizing shrimp growth and reducing waste, which accounts for a substantial portion of the production cost. The paper presents an integrated monitoring system that collects acoustic sound of shrimp feeding behavior and water quality characteristics. Acoustic data, recorded manually and streamed to the cloud, provides insights into shrimp feeding patterns, while continuous monitoring of parameters like pH, dissolved oxygen (DO), temperature, and oxidation-reduction potential (ORP) offers a comprehensive view of water conditions. The system was deployed at a commercial shrimp pond at Cam Ranh, Nha Trang to collect data over a shrimp crop cycle.

The results reveal that acoustic analysis can accurately detect distinct feeding behaviors, suggesting opportunities for precision feeding strategies. Additionally, water quality parameters, especially DO and temperature, follow consistent daily patterns that correspond to solar activity that can be used to optimally control oxygen aerator. It paves the way for further research into precision feeding using

B. Bui · B. Tran · H. Nguyen · H. Cao · S. Nguyen
Department of Electronics Engineering, Faculty of Electrical-Electronics Engineering, Ho Chi Minh City University of Technology (HCMUT), VNU-HCM, Ho Chi Minh City, Vietnam

K. Nguyen
Systems Design Lab (d.lab), The University of Tokyo, Tokyo, Japan

S. Nguyen · H. Nguyen · L. Nguyen
Institute of Aquaculture, Nha Trang University, Nha Trang, Vietnam

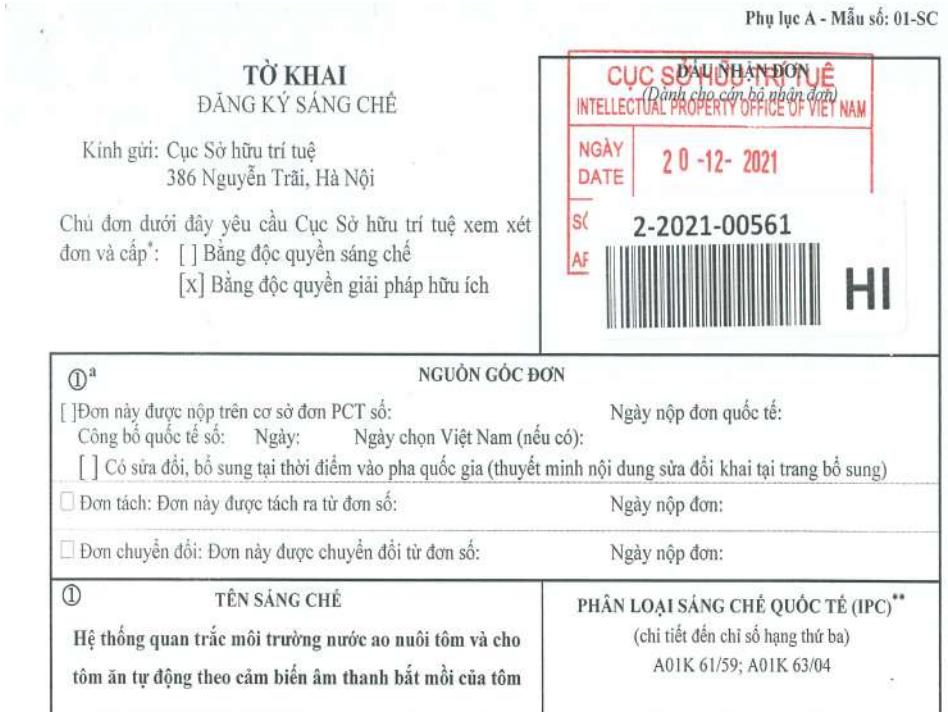
Y. Nguyen
MnM System Design LLC, Palmdale, CA, USA

H. Nguyen
Soitec, Bernin, France

H. Tran (✉)
Department of Science and Technology, Nha Trang University, Nha Trang, Vietnam
e-mail: myhanhtt@ntu.edu.vn

N. T. Hai et al. (eds.), *EAI International Conference on Renewable Energy and Sustainable Manufacturing*, EAI/Springer Innovations in Communication and Computing, https://doi.org/10.1007/978-3-031-60154-5_39

(Q4 paper)



Phụ lục A - Mẫu số: 01-SC

TỜ KHAI
ĐĂNG KÝ SÁNG CHẾ

Kính gửi: Cục Sở hữu trí tuệ
386 Nguyễn Trãi, Hà Nội

Chú đơn dưới đây yêu cầu Cục Sở hữu trí tuệ xem xét đơn và cấp*: [ ] Bằng độc quyền sáng chế
[x] Bằng độc quyền giải pháp hữu ích

ĐẦU NHẬN ĐƠN
(Dành cho cán bộ nhận đơn)
CỤC SỞ HỮU TRÍ TUỆ
INTELLECTUAL PROPERTY OFFICE OF VIET NAM
NGÀY DATE 20-12-2021
SỐ 2-2021-00561
HI

① NGUỒN GỐC ĐƠN

[ ] Đơn này được nộp trên cơ sở đơn PCT số: Ngày nộp đơn quốc tế:
Công bố quốc tế số: Ngày: Ngày chọn Việt Nam (nếu có):
[ ] Có sửa đổi, bổ sung tại thời điểm vào pha quốc gia (thuyết minh nội dung sửa đổi khai tại trang bổ sung)
☐ Đơn tách: Đơn này được tách ra từ đơn số: Ngày nộp đơn:
☐ Đơn chuyển đổi: Đơn này được chuyển đổi từ đơn số: Ngày nộp đơn:

① TÊN SÁNG CHẾ
Hệ thống quan trắc môi trường nước ao nuôi tôm và cho tôm ăn tự động theo cảm biến âm thanh bắt mồi của tôm

PHÂN LOẠI SÁNG CHẾ QUỐC TẾ (IPC)**
(chi tiết đến chỉ số hạng thứ ba)
A01K 61/59; A01K 63/04

(patent)

Societal Impact:

- **Provide** early warning to aquaculturists of detrimental changes in critical environmental parameters affecting aquatic animals, mitigating risks

- **Minimize** mortality loss, reducing feed cost, and promoting sustainable and profitable adoption for aquaculture farming for areas along the Mekong river including Lao, Cambodia, and Vietnam including 3M small shrimp farmers

- **Support** the training of students, master's students and farmers:
  - students (11 bachelors, 5 engineers) in NTU and 4 bachelors students in PTIT, 4 bachelors students in HCMUT
  - two master's students and farmers

- **Reduce** environmental contamination by reducing chemical and antibiotics usage in both aquaculture and agricultural farming

- **Help** students have a good opportunity to have access to new technology, and enhance their practical ability as well as creativity in the process of conducting experiments to apply this technology in shrimp farming.





Conclusions:

No.	Main activities	Members	Status/Remarks
1	System and algorithm design	PTIT, Soitec, UTokyo	Done
2	Sensing node design and testing	PTIT & IICT	Done
3	Controllers design and testing	UTokyo	Done
4	Gateway design and testing	UTokyo & IICT	Done
5	Cloud and database	MMU & BLU	Done
6	System fabrication and verification	LEO	Done
7	Field test	NTU, BLU	Done
8	System optimization	All	Done

Future works:

- ✓ Publication
- ✓ System optimization
- ✓ Research and Development and Technology
- ✓ Finding Funds to Develop the System

Thanks you