A mesh-topological, low-power wireless network platform for a smart watering system

Background :

The plant watering system lies at the heart of agriculture since it directly affects product yields, as well as the quality of products. Therefore, controlling when plants should be watered and determining how much water the plants need concerning the current environmental conditions are crucial for the plant growth.

Targets :

- Developing weather stations, sensor nodes, valve-control nodes, and a controller node
- Developing a smart watering system based on a mesh-topological WSN
- Developing a smart watering system based on a NerveNet-LoRa WSN

Speaker : Udom Lewlompaisarl
National Electronics and Computer Technology Center, Thailand

A mesh-topological, low-power wireless network platform for a smart watering system

Project Members :

National Electronics and Computer Technology Center (NECTEC)
National Institute of Information and Communications Technology (NICT)
Universiti Teknology Brunei (UTB)
Department of Agriculture and Agrifood (DAA)
University of Computer Studies, Yangon (UCSY)
Universiti Teknology Malaysia (UTM)

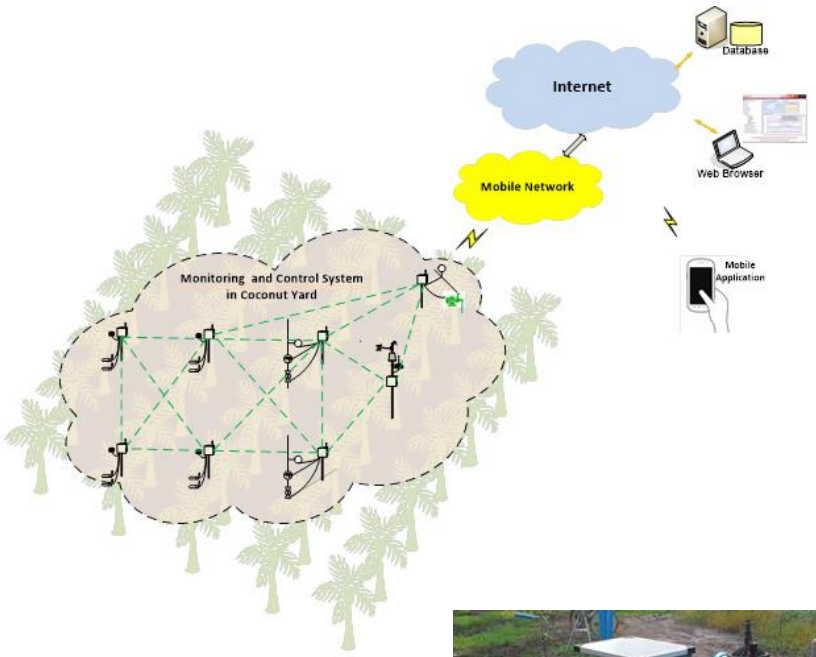
Project Duration : 3 years (Jun 2018 – **May 2022**) (Request for 1-year extension)

Project Budget: 116,000 USD

Project Activities

System Overview

Experiments at Kehakaset Coconut Farm, Pathum Thani, Thailand



Project Activities

2018

- Kick-off meeting at NICT, Japan (Jul 2018)
- NECTEC-NICT technical meeting on NerveNet application at NECTEC, Thailand (Aug 2018)
- A draft of CRDA
- Experiment with NerveNet/LoRa at NECTEC, Thailand (Sep 2018)
- Visiting Brunei's site by Thanika-san (Nov 2018)

2019

- 2nd Meeting at UTB, Brunei (Jan 2019)
- System implementation and testing for UTB (Feb – Oct 2019)
- Special meeting with Dr Jennifer's team (ET-based Irrigation) for research idea exchange and collaboration in Bangkok (Mar 2019)
- 3rd Meeting at UCSY, Myanmar (Jul 2019)
- CRDA issues!

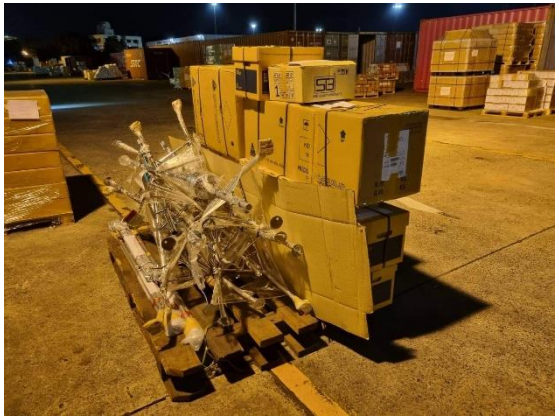
Project Activities

2020

- Completion of CRDA
- 4th Meeting (WebEx) on April 8, 2020
- Equipment purchase & system installation in Brunei
- System requirement for the experimental site in Myanmar

2021

- Shipping the additional sensor nodes to UTB, Brunei
- Developing a system for UCSY, Myanmar (Ready for shipping)

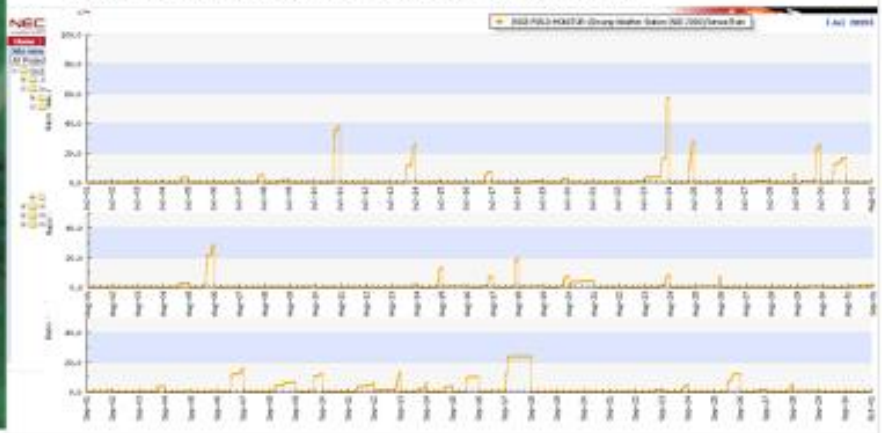


Project Activities in Brunei Darussalam

Weather station at Imang Dam

Imang Dam – Weather station

Data collected real-time: Daily and monthly view



Project Activities in Brunei Darussalam

New location of the paddy site

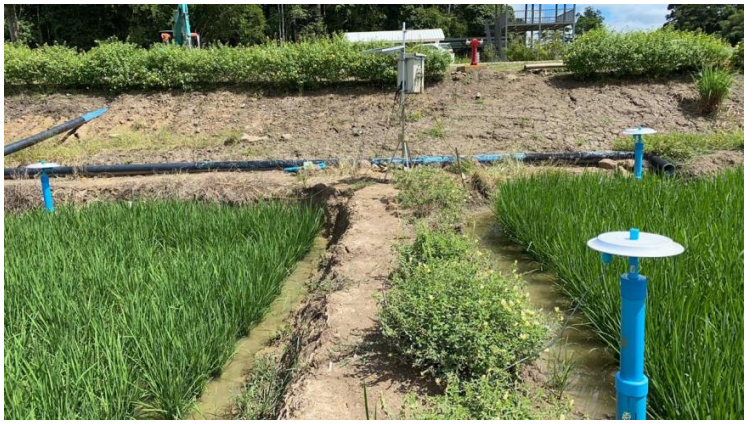
- IBTE Agro 7.7km from Imang Dam
- Wasan office – IBTE 5km

Project Activities in Brunei Darussalam

IBTE Agro: First trial 2020 (Jul – Sep Season)





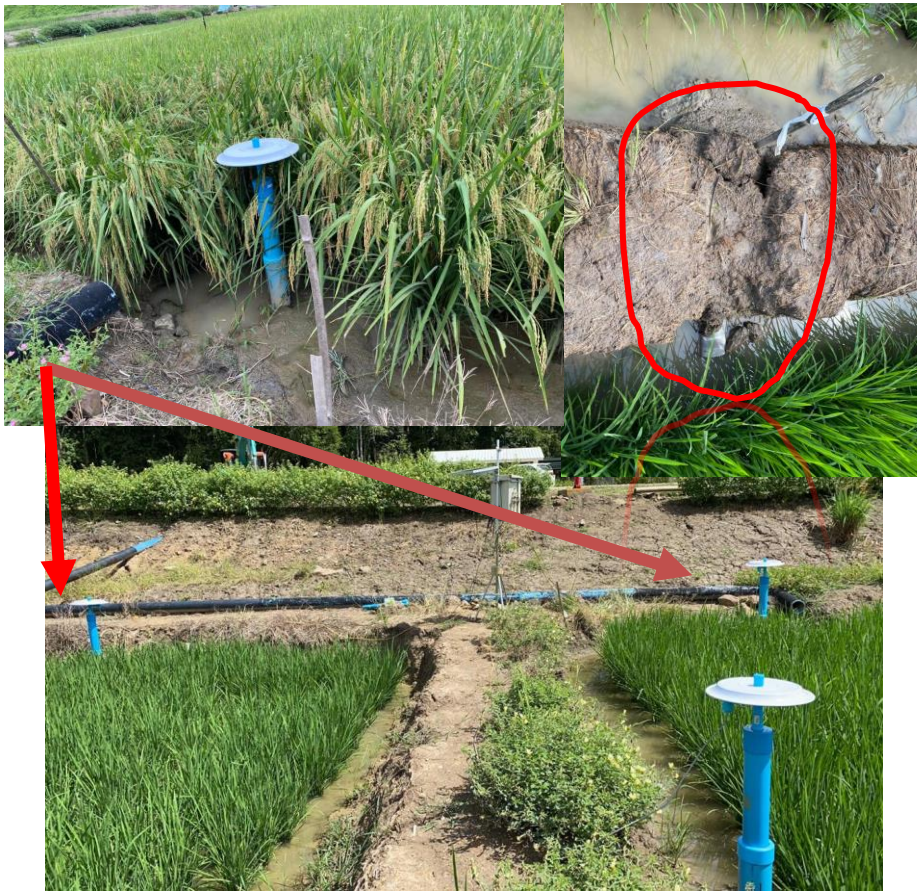



Project Activities in Brunei Darussalam

Next step: To improve current setting to the new plot

- **Wasan** – Plot irrigation collected via canal

- **IBTE** – Plot irrigation direct via pipe



- Need to work on the water-gate

Project Activities in Brunei Darussalam

Meeting ID: 892 9202 7614
Passcode: 911356

National Institute of Information and Communications Technology

The SWS Paddy Plantation Workshop
Theme: Lessons Learned on Paddy within the Region
10 March 2021, 8.00am – 4.00pm
Lecture Theatre 2, Library Complex, UTB, Brunei

Prof Dr Hjh Zohrah Hj Sulaiman,
Vice Chancellor, UTB
Guest of Honor

Mr Masugi Inoue
Director of Global Alliance Dept,
NICT JAPAN

Dr Wida Susanty Hj Suhaili
Country Lead SWS Paddy

Dyg Khairunnisa
Haji Omar, DAA

Puan Hjh Rosita
Hassan, BSP

Nurzuraine Hj
Kamarulzaman, UBD

Dr Wida Susanty
Hj Suhaili, UTB

Session 1: Brunei's Paddy Industry

Dr Au Thien Wan,
UTB

Theodoro Correa Jr.,
ZES IRRI,

Session 2: International Best Practices (IRRI)

Dr Saleem Nazmudeen,
UTB

Dr Sharifah Hafizah
Syed Ariffin,
UTM, Malaysia

Udom Lewlomphaisarl,
NECTEC, Thailand

Dr Denni Kurniawan,
UTB, Brunei

Session 3: Adoption of Technology

Dr Nurzal Effiyana,
UTM

Dr Wida Suhaili,
UTB

Session 4: Best Practices within the region

Prof Md Razi Ismail,
UPM, Malaysia

Dr Ir Basuki Sumiwanata,
IPB, Indonesia

Prof Morteza Jami,
UTB, Brunei

Bru-SWS Stakeholders

Project Activities in Brunei Darussalam

Deploy following the planting season

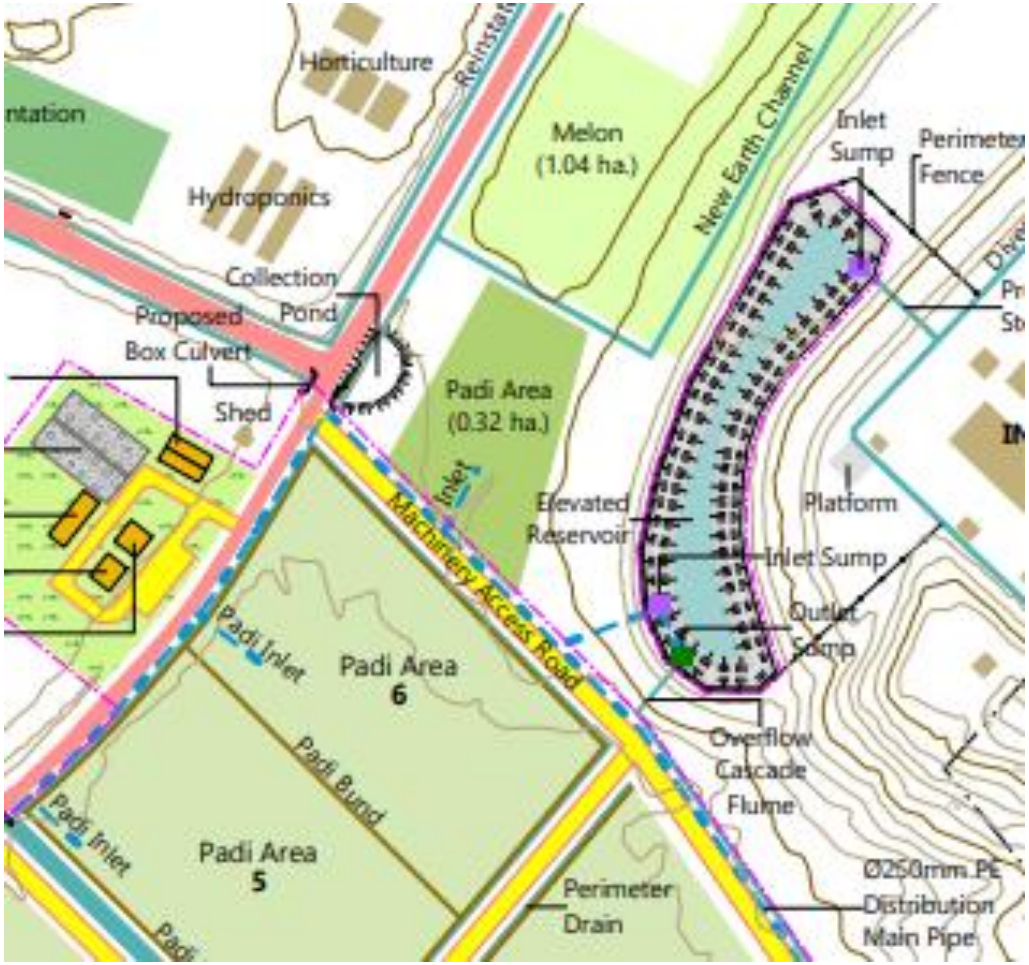


Problems encountered




Project Activities in Brunei Darussalam

Improved setup @Agro



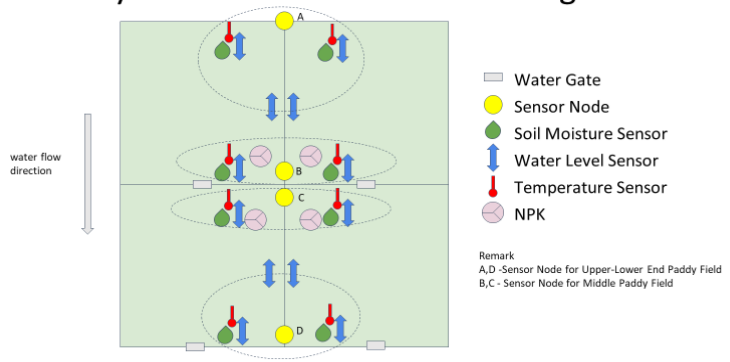
UPPER

Required
Upper Reservoir
- Water level
- Sensor station (gateway)

Paddy field
- Sensor station
- Water level
- Soil moisture
- Temperature
- NPK
- pH

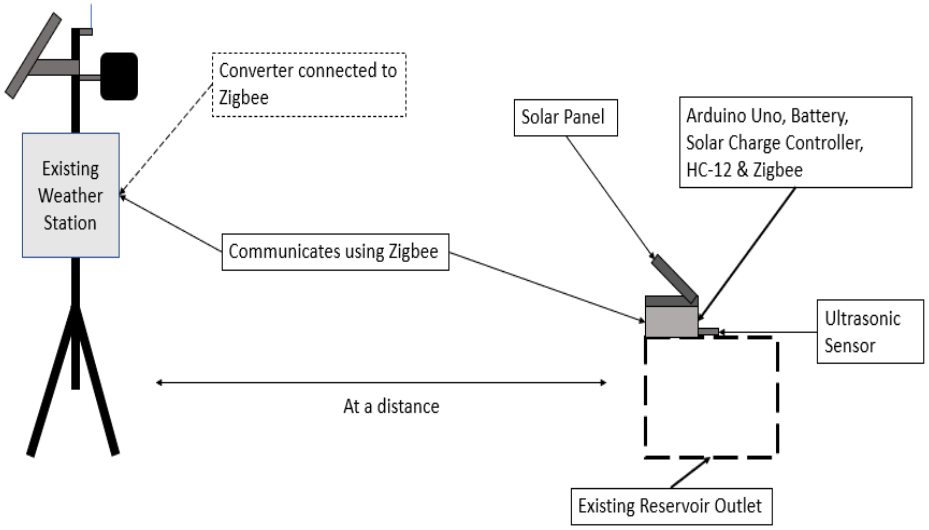
New setting for sensors

Paddy Field Sensor and Node Sitting

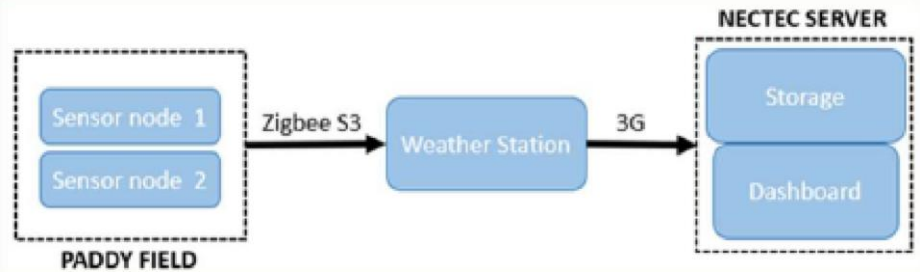


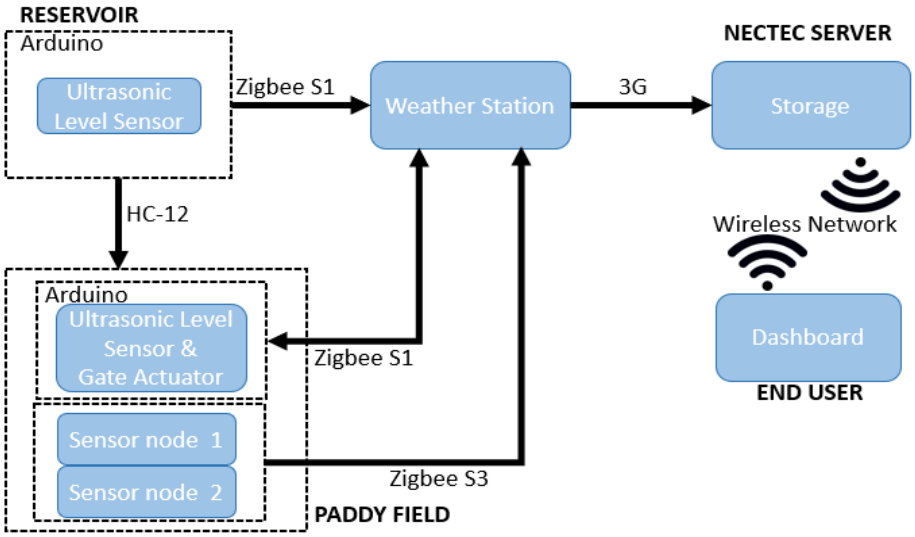
Project Activities in Brunei Darussalam

Water Gate Development



Reservoir Adaptive Development





Presentations at International Conferences, Seminar and Workshops:

No:	Project/Paper title:	Author names	Affiliation	Conference/Seminar/Workshop name:	The date of the conference	The venue of the conference
1.	Low-cost Watergate Component for Smart Watering System	Denni Kurniawan, Wida Susaty Haji Suhaili	Universitti Teknologi Brunei	SWS Paddy Plantation Workshop	10 March 2021	Online
2.	Usage of Technology in Increasing Farm Production and Productivity	Wida Susanty Hj Suhaili	Universitti Teknologi Brunei	MYCE2021: Agricultural Sector: Challenges and Way Forward	11 = 12 June 2021	Online
3	IoT Adoption to address water level issues for paddy plantation in IBTE Agro **(BICET_100)**	*Mohamad Zuhair Arif Haji Shahrum, Dr Wida Susanty Haji Suhaili and Dr Au Thein Wan*	Universitti Teknologi Brunei	8th Brunei Internatioal Conference on Engineering and Technology 2021	8-10 November 2021	Online
4.	Design of Floatation Water Gate for Paddy Field Irrigation (BICET_171)	*Muhamad Naqiuddin Awang Rambli, Pg Dr Seri Rahayu Pg Ya'Akub, Dr Denni Kurniawan, Dr Wida Susanty Haji Suhaili, Muhamdilah Morni, Pg Dr Rafidah Pg Hj Petra and Hj Ismit Hj Mohamad*	Universitti Teknologi Brunei	8th Brunei International Conference on Engineering and Technology 2021	8-10 November 2021	Online
5.	Adoption of technology to improve self-sufficiency in paddy plantation in Brunei: Challenges and mitigation strategies for intermediate stakeholders.	Wida Susanty Haji Suhaili	Universiti Teknologi Brunei	International Conference on Sustainable Agriculture and Biosystem 2021	24-25 November 2021	Online http://icsab.fateta.unand.ac.id/

Project Activities in Myanmar

Meeting @UCSY



Green House Site @UCSY

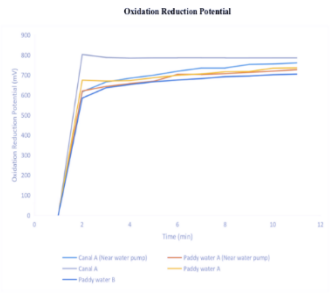

Mango Farm site @on the way to Kungyangon


Meeting @Tawku Village

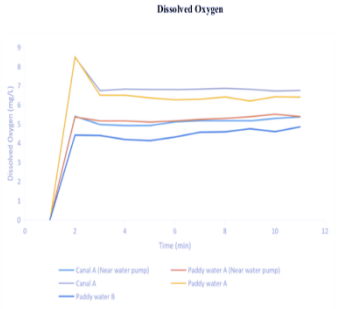

Paddy Field site @Khalauktayar Village


Project Activities in Malaysia (2020)

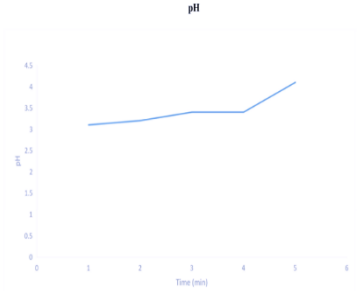
Paddy Field Water Quality Data Analysis Using ANOVA Approach



Oxidation Reduction Potential



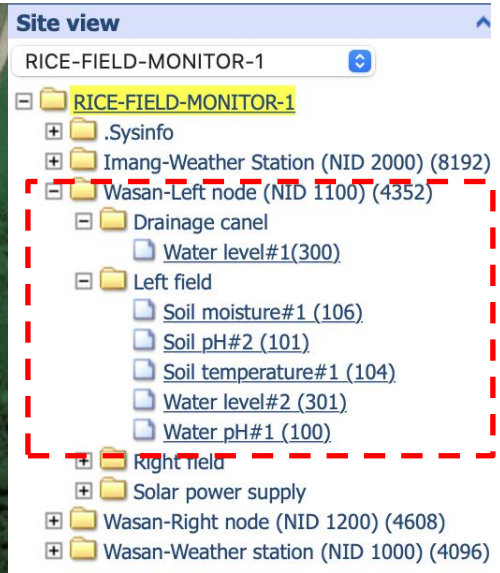
Dissolved Oxygen



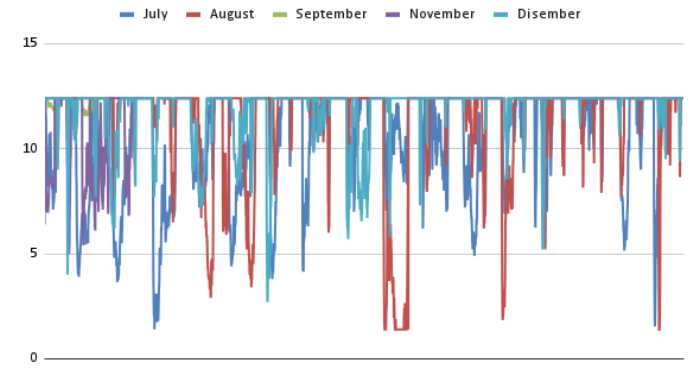
pH

Project Activities in Malaysia (2021)

Analysis of Wasan-Left Node (NID1100) 4352 Data Analysis Using ANOVA Approach



Soil PH

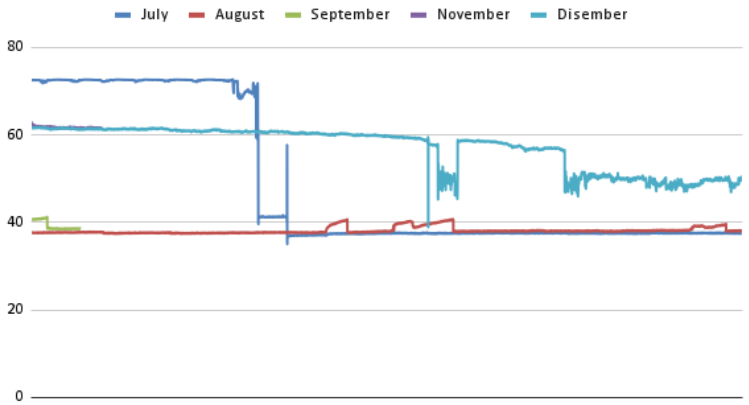


Source	Df	Sum of Square	Mean Square	F Statistic	P-value
Groups (between groups)	4	2506.568637	626.642159	233.389000	0.00000
Error (within groups)	2330	6255.977051	2.684969		
Total	2334	8762.545688	3.754304		

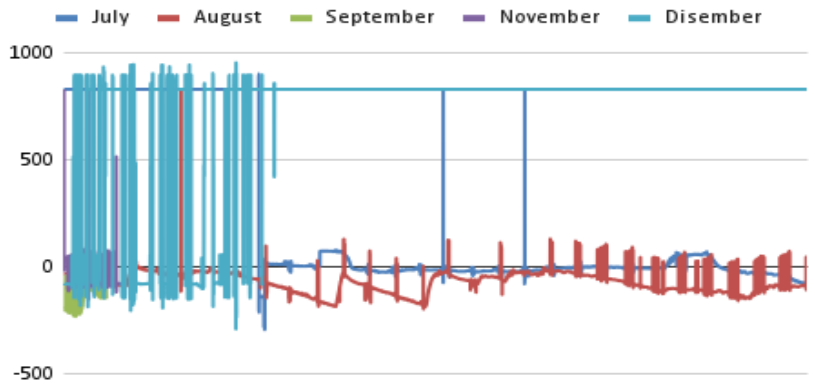
Project Activities in Malaysia

Analysis of Wasan-Left Node (NID1100) 4352 Data Analysis Using ANOVA Approach

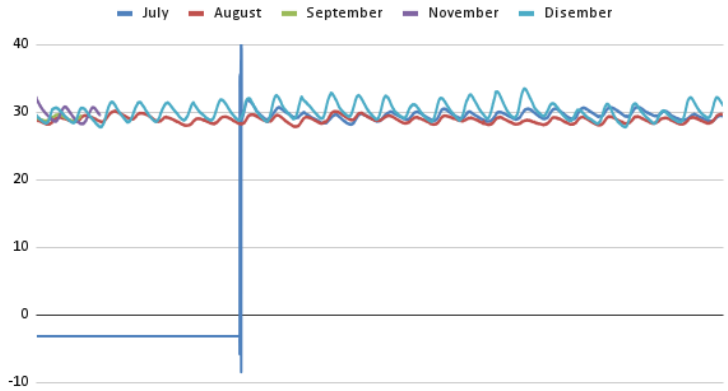
Soil Moisture



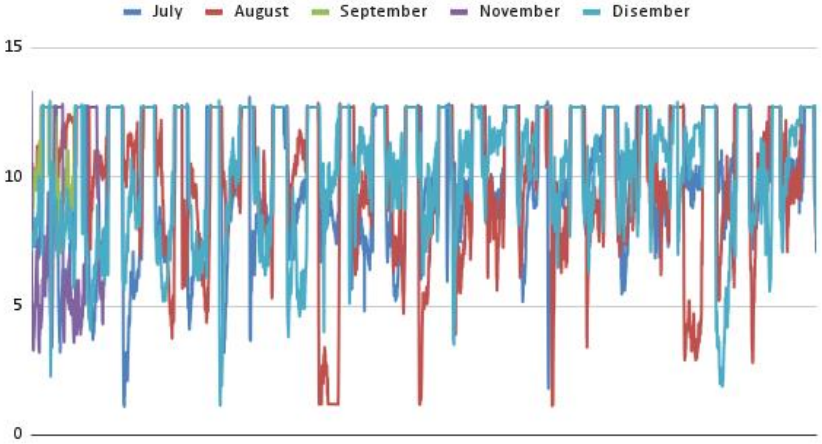
Water Level



Soil Temperature

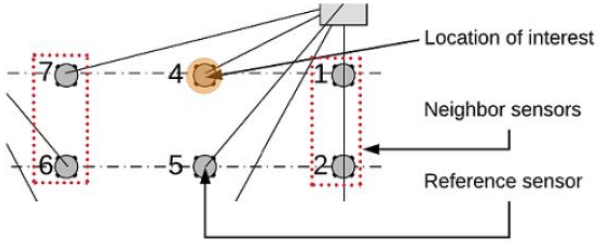


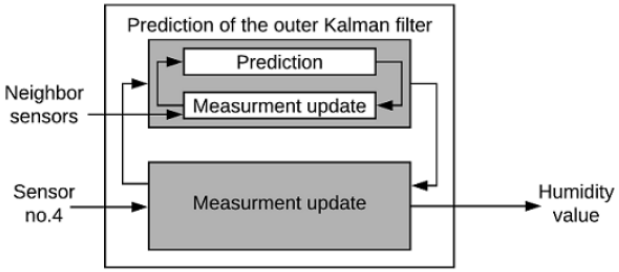
Water pH

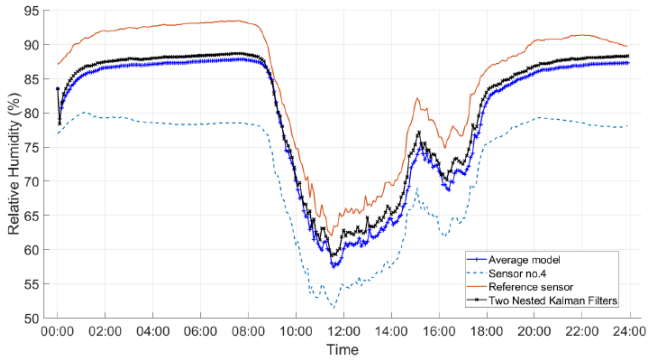


Experiments with data collected from the system

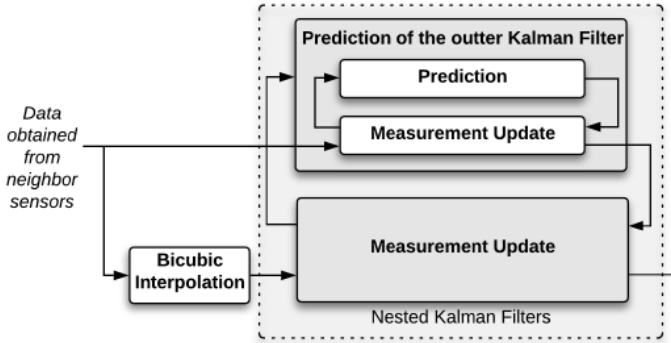
- Humidity sensor accuracy improvement based on two nested Kalman filters (2NKF)

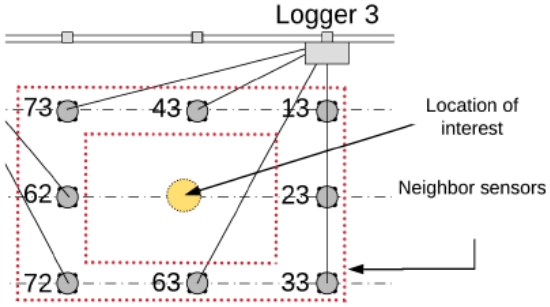


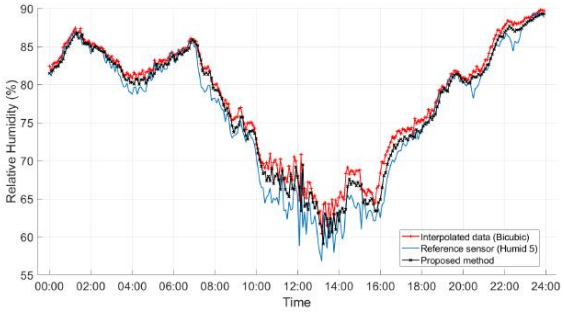




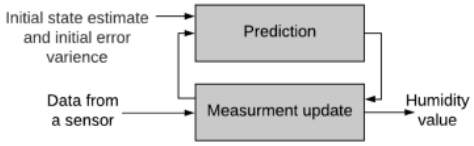
- Relative humidity estimation based on 2NKF with bi-cubic interpolation

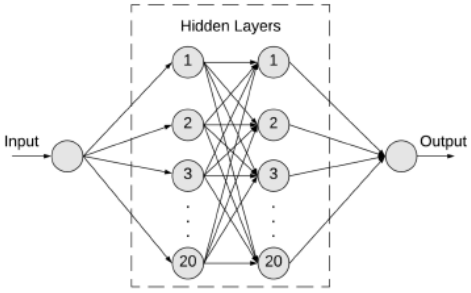


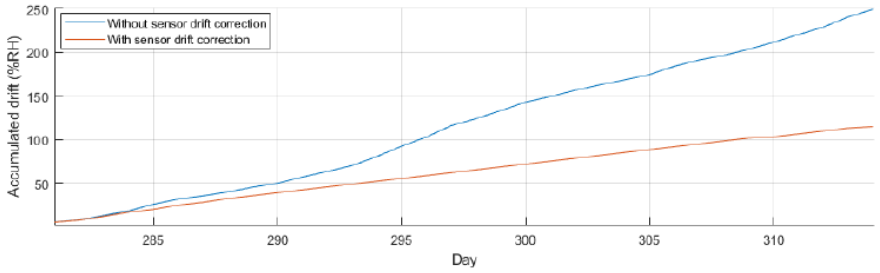




- Humidity sensor drift detection and correction based on ANN and KF







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.	A Design for IoT Based Smart Watering System Using LoRa	Khin Than Mya[1], Myint Myint Sein[1], Thi Thi Soe Nyunt[1], Udom Lewlompaisarl[2], and Yasunori Owada[3]	[1]University of Computer Studies, Yangon, [2]National Electronics and Computer Technology Center, [3]National Institute of Information and Communications Technology	2020 IEEE 9th Global Conference on Consumer Electronics (GCCE 2020)	13-16 October 2020	Online
2.	Humidity Sensor Accuracy Improvement Based on Two Nested Kalman Filters for Commercial Cultivation of Tropical Orchids	P. Dangsakul[1], N. Siripool[1,2], K. Sirisanwannakul[1,2], R. Keinprasit[1], K. Rungprateeptavorn[1], S. Keerativittayanun[1], and J. Karnjana[1]	[1]National Electronics and Computer Technology Center, [2]Sirindhorn International Institute of Technology	The 27th International Conference on Neural Information Processing	18-22 November 2020	Online
3.	Relative Humidity Estimation Based on Two Nested Kalman Filters with Bicubic Interpolation for Commercial Cultivation of Tropical Orchids	N. Siripool[1,2], K. Sirisanwannakul[1,2], W. Kongprawechnon[2], P. Dangsakul[1], A. Leelayuttho[1], S. Chokrung[1], J. Intha[1], S. Keerativittayanun[1], and J. Karnjana[1]	[1]National Electronics and Computer Technology Center, [2]Sirindhorn International Institute of Technology	International Symposium on Integrated Uncertainty in Knowledge Modelling and Decision Making	11-13 November 2020	Online
4.	Humidity Sensor Drift Detection and Correction Based on a Kalman Filter with an Artificial Neural Network for Commercial Cultivation of Tropical Orchids	K. Sirisanwannakul[1,2], N. Siripool[1,2], W. Kongprawechnon[2], P. Dangsakul[1], U. Lewlompaisarl[1], S. Sartsatit[1], T. Duangtanoo[1], S. Keerativittayanun[1], Wida Susanty Haji Suhaili[3], Y. Owada[4], Khin Than Mya[5], Sharifah Hafizah Syed Ariffin[6], and J. Karnjana[1]	[1]National Electronics and Computer Technology Center, [2]Sirindhorn International Institute of Technology, [3]Universiti Teknologi, [4]National Institute of Information and Communications Technology, [5]University of Computer Studies, Yangon, [6]Universiti Teknologi Malaysia	The 4th International Conference on Computational Intelligence in Information System (CIIS 2020)	25-27 January 2021	UTB, Brunei Darussalam & Online

Societal Impact:

- A direct social impact of the proposed system is straightforward; that is, it improves farming productivity both in quality and quantity. Therefore, it can be an answer to the world's food shortage crisis. Furthermore, it has many impacts on various applications that share the same technological infrastructure. Since this work aims to study and implement, as well as to experiment with, a stable and reliable wireless platform with low-power consumption, the studied platform can be applied in other domains, such as environmental/earth sensing, area monitoring, and healthcare monitoring.

Conclusion:

Activities that have been done so far in 2021 are summarized as follows.

- **Meetings**: 4th Meeting (WebEx)
- **Experiments**
  - System installation in Brunei
  - System requirements and development in Myanmar (Note: Due to the pollical situation in Myanmar and the COVID-19 situation, the experiments in Myanmar are canceled. And we have a plan to use the system developed for Myanmar to be installed and tested in Thailand in December 2021.)
  - Data analysis
- **Publications**: 4 conference papers

Targets

- Developing weather stations, sensor nodes, valve-control nodes, and a controller node … **DONE**
- Developing a smart watering system based on a mesh-topological WSN … **DONE**
- Developing a smart watering system based on a NerveNet-LoRa WSN … **ONGOING**

Future works:

- System testing in Thailand
- NerveNet/LoRa-based system (Target: Thailand)
- Data collection and analysis
- Publications

Activities	2021		2022				
	Nov	Dec	Jan	Feb	Mar	Apr	May
Conference							
Journal							
Field tests							
Purchase							