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 Lewlomphaisarl (Project Leader) and Jessada Karnjana (Speaker)
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 Teknologi Brunei (UTB)
Department of Agriculture and Agrifood (DAA)
University of Computer Studies, Yangon (UCSY)
Universiti Teknologi Malaysia (UTM)

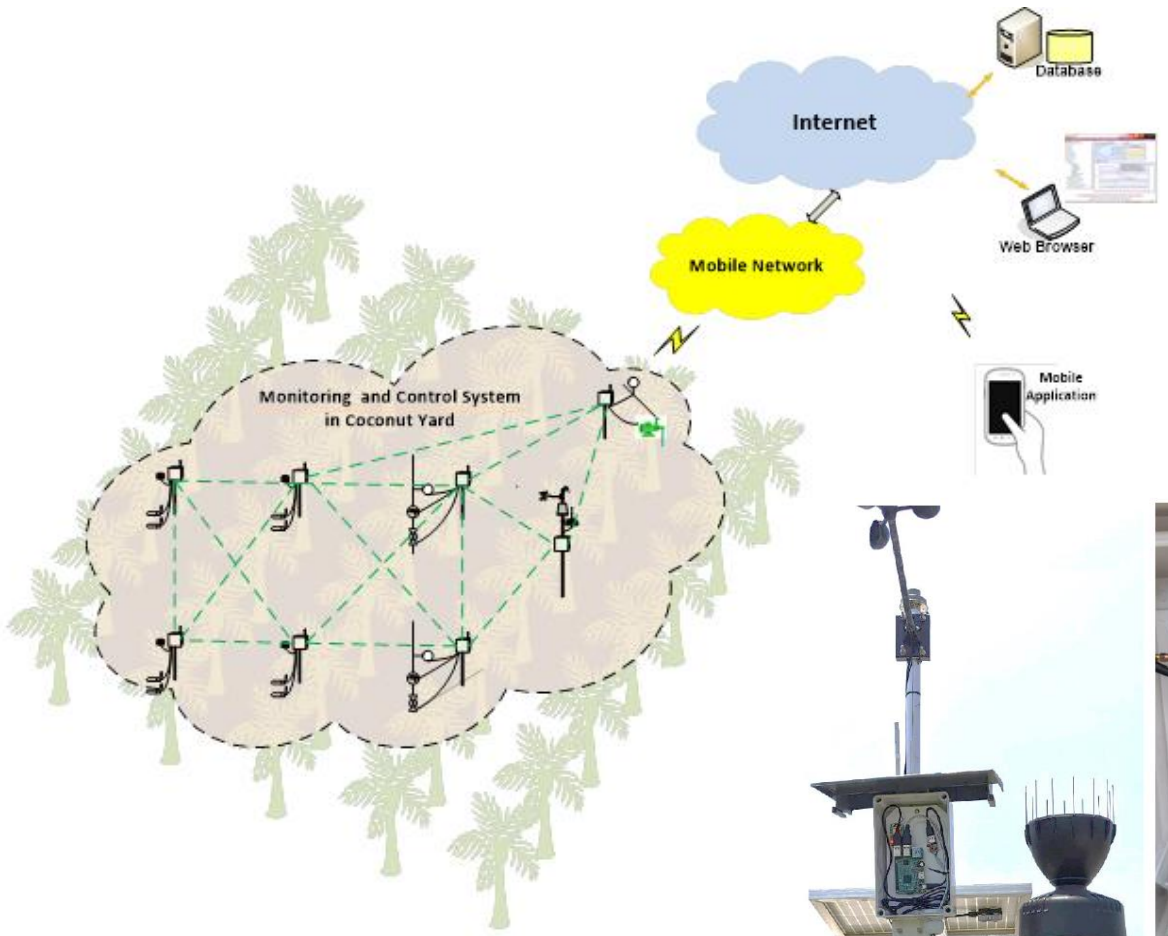
Project Duration : 3 years (Jun 2018 – **May 2022**) (Request for 1-year extension)

Project Budget: 116,000 USD

Project Activities

System Overview

Experiments at Kehakaset Coconut Farm, Pathum Thani, Thailand



Gateway

Weather Station

Sensor Node

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)

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

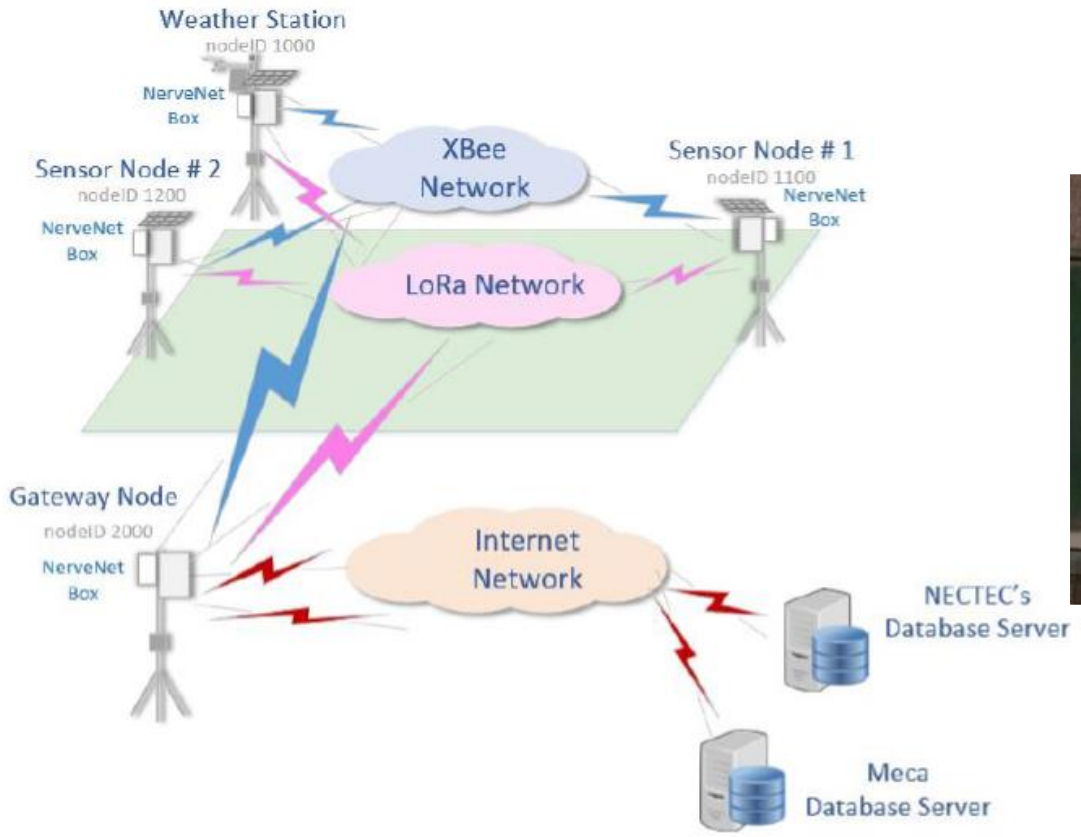
2021

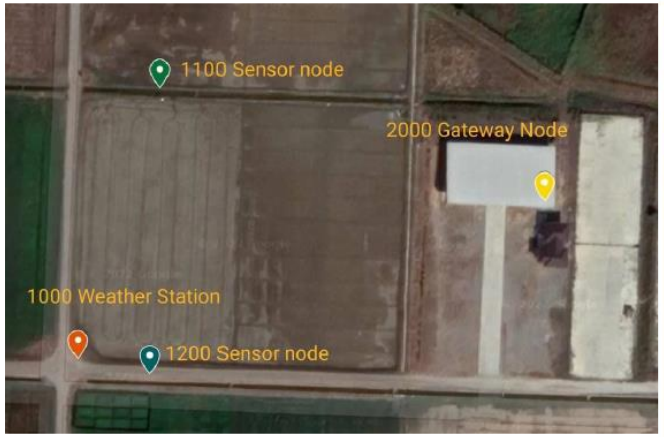
- Shipping the additional sensor nodes to UTB, Brunei
- Developing a system for UCSY, Myanmar (Ready for shipping)
- 5th Meeting (WebEx) on 28 Jan 2021

Project Activities in Thailand

2022

- Experiments in Myanmar were canceled!
- **NerveNet-RoLa** vs **XBee** installation & testing in (Jan 14, 2022) @ National Institute of Rice Science, Supahnburi, Thailand

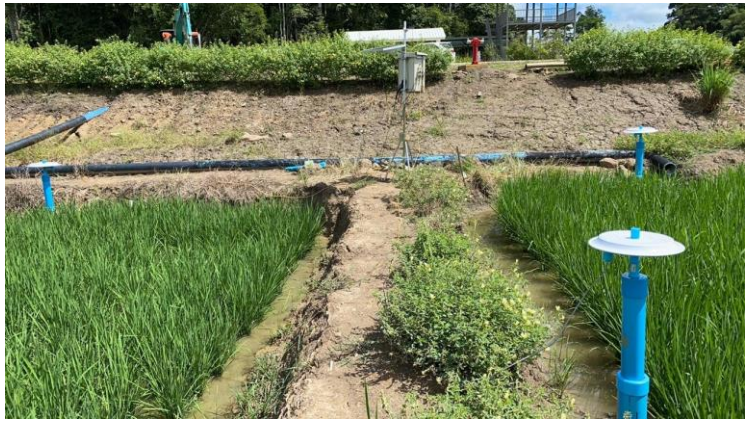




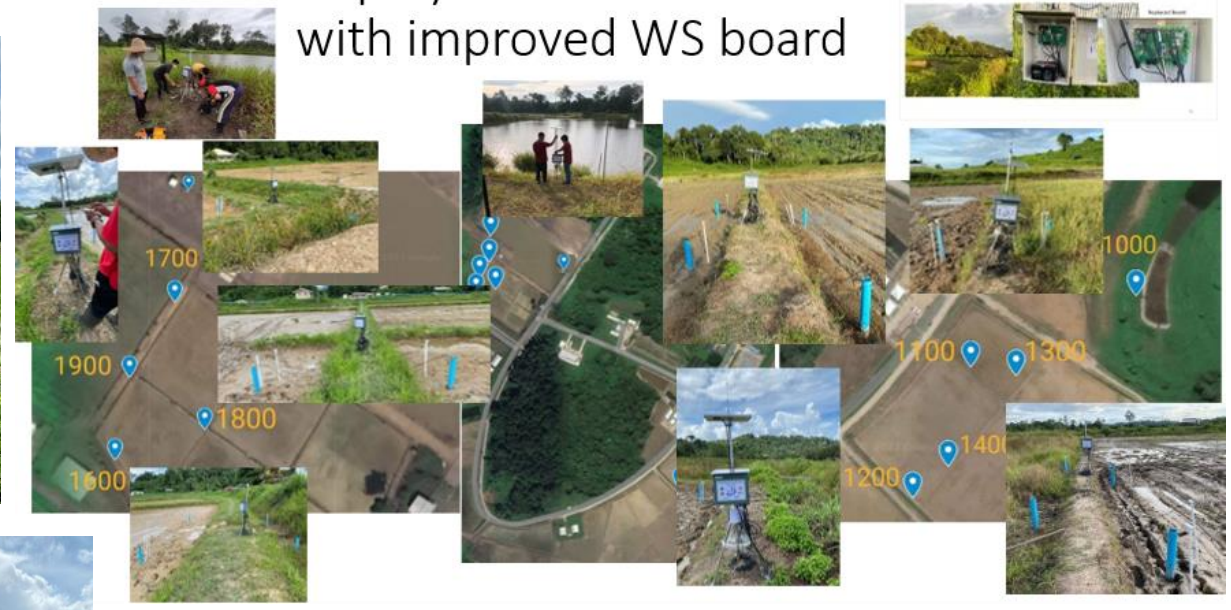
Project Activities in Brunei Darussalam

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

Revisions: early June 2021



Deployed new version with improved WS board



Project Activities in Myanmar

Meeting @UCSY



Green House Site @UCSY

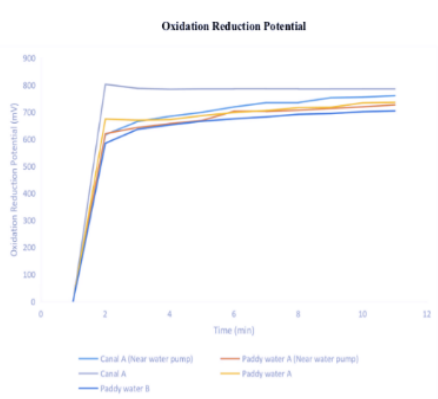

Mango Farm site @on the way to Kungyangon

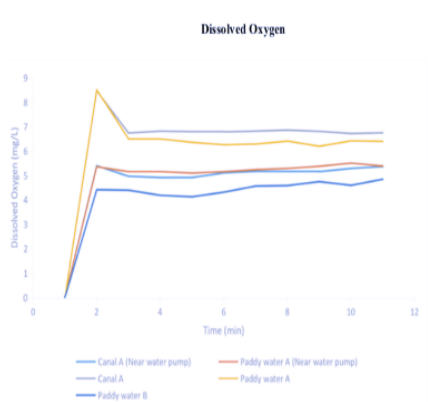

Meeting @Tawku Village

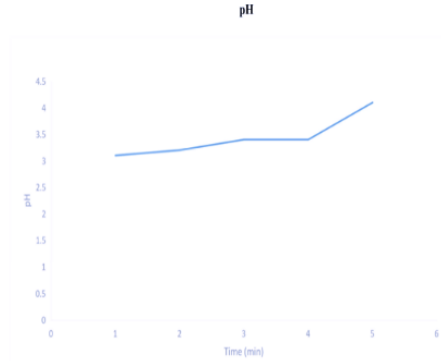

Paddy Field site @Khalauktayar Village


Project Activities in Malaysia

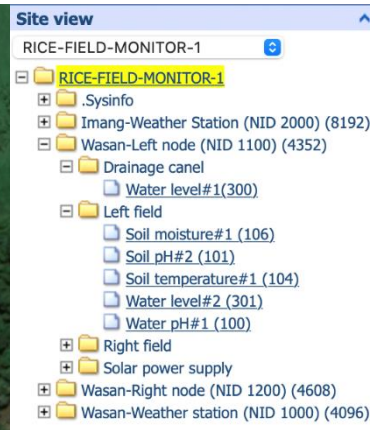
Paddy Field Water Quality Data Analysis Using ANOVA Approach



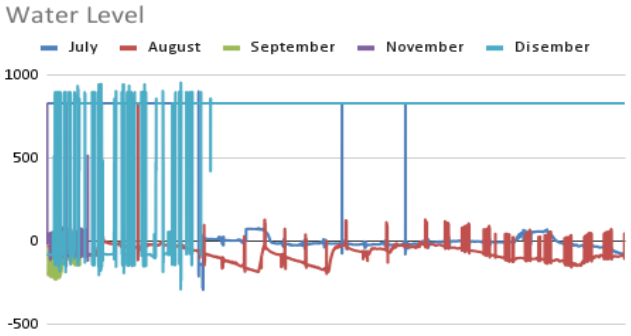


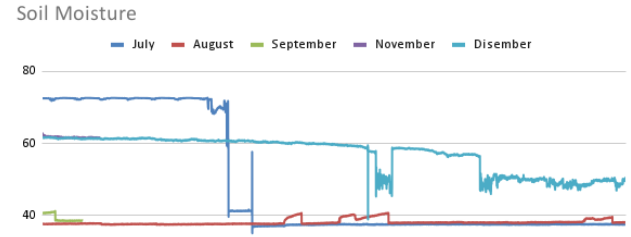


Analysis of Wasan-Left Node (NID 1100) 4352 Data Analysis Using ANOVA Approach



- Water pH
- Water level
- Soil temperature
- Soil pH
- Soil moisture

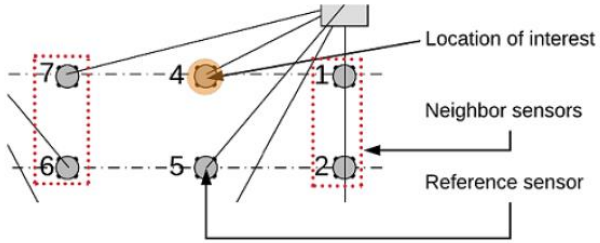


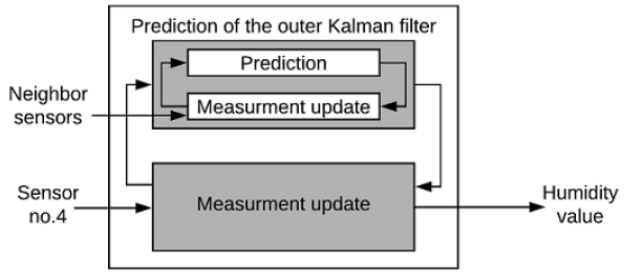


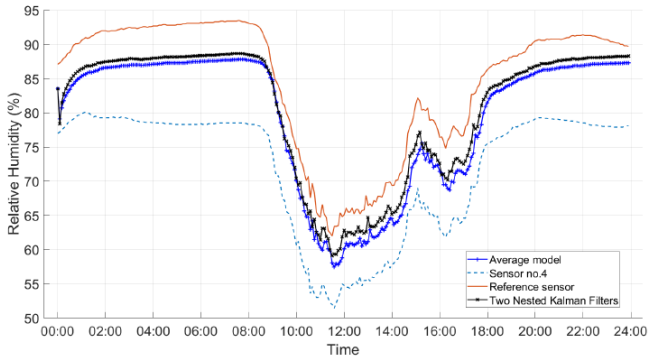
R&D results

- Field prototypes of the smart watering system (tailor-made)
- Data
- Data analysis techniques

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

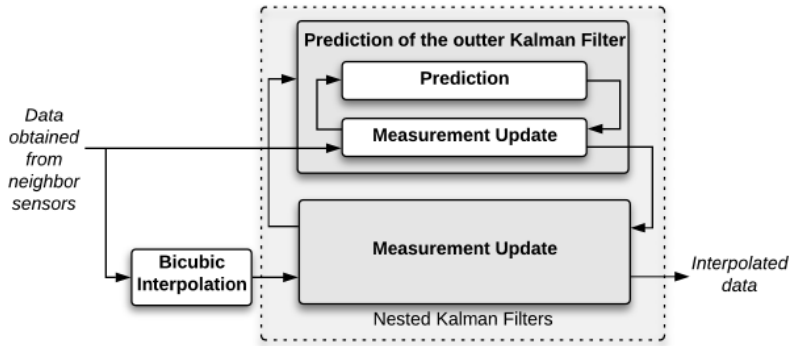


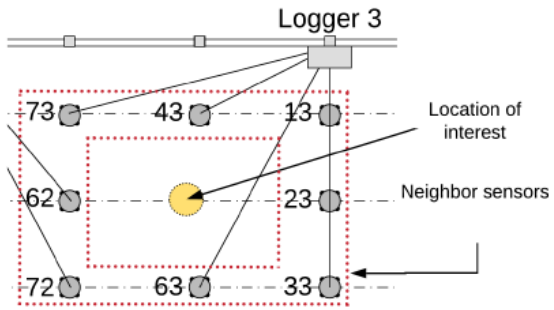


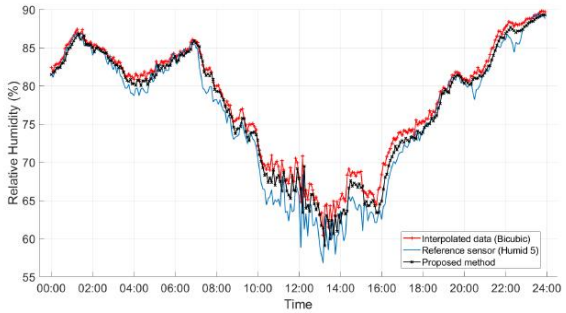


- RMSE was reduced by 22%

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

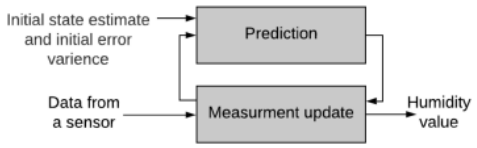


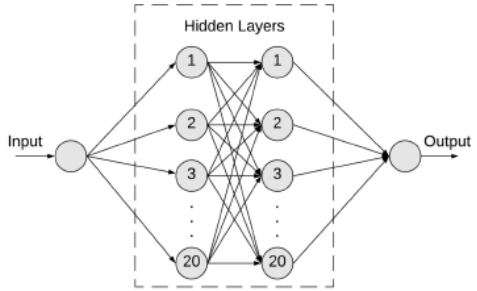


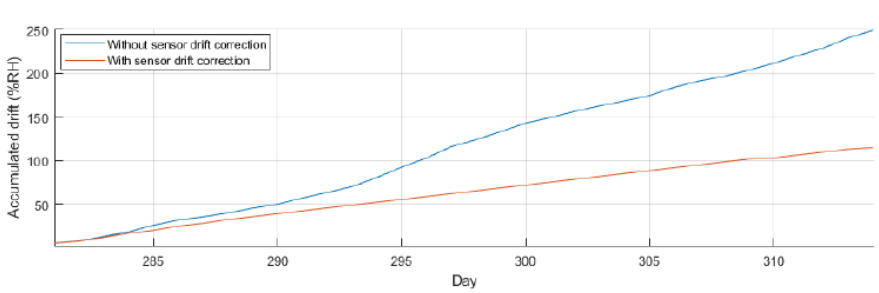


- 3.4 times faster than Kriging
- RMSE was reduced by 18%

Humidity sensor drift detection and correction based on ANN and KF







- Accumulated drift was reduced by 55%

Scientific Contribution

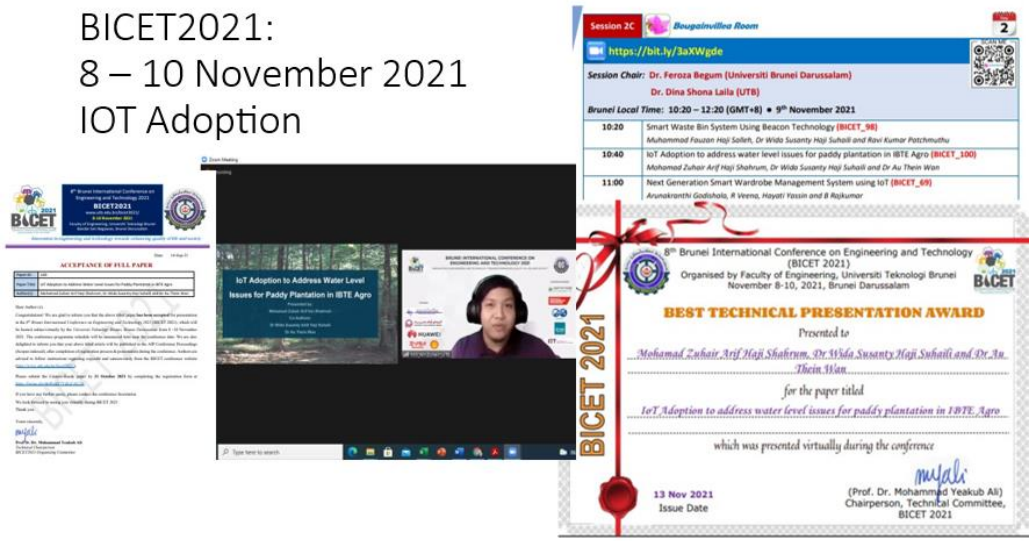
Presentations at International Conferences:

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

Scientific Contribution

Other presentations

BICET2021:
8 – 10 November 2021
IOT Adoption

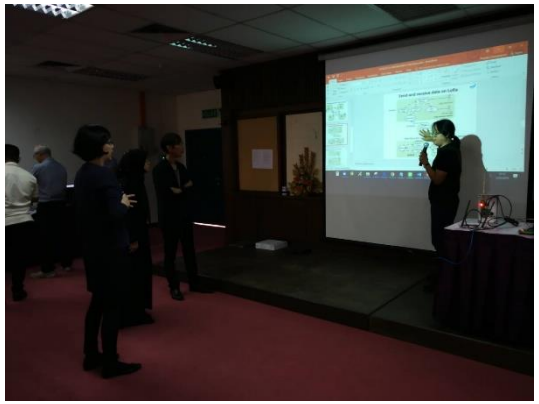


Presentations
24 – 25Nov 2021

Presentations

Scientific Contribution

Other presentations



Demo of NerveNet/LoRa
March 2019
USM, Malaysia

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 during the project period.

- **Meetings**: 5 meetings
- **R&D and Experiments**
  - Tailor-made systems
  - System installation and testing in Brunei
  - System installation and testing in Thailand
  - Data
  - Data analysis techniques
- **Publications**: 4 conference papers
- **Other Presentations**: 6 conferences/workshops/meetings

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 … **DONE**