

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 (Project Leader) and Jessada Karnjana (Speaker)
National Electronics and Computer Technology Center, Thailand



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 :

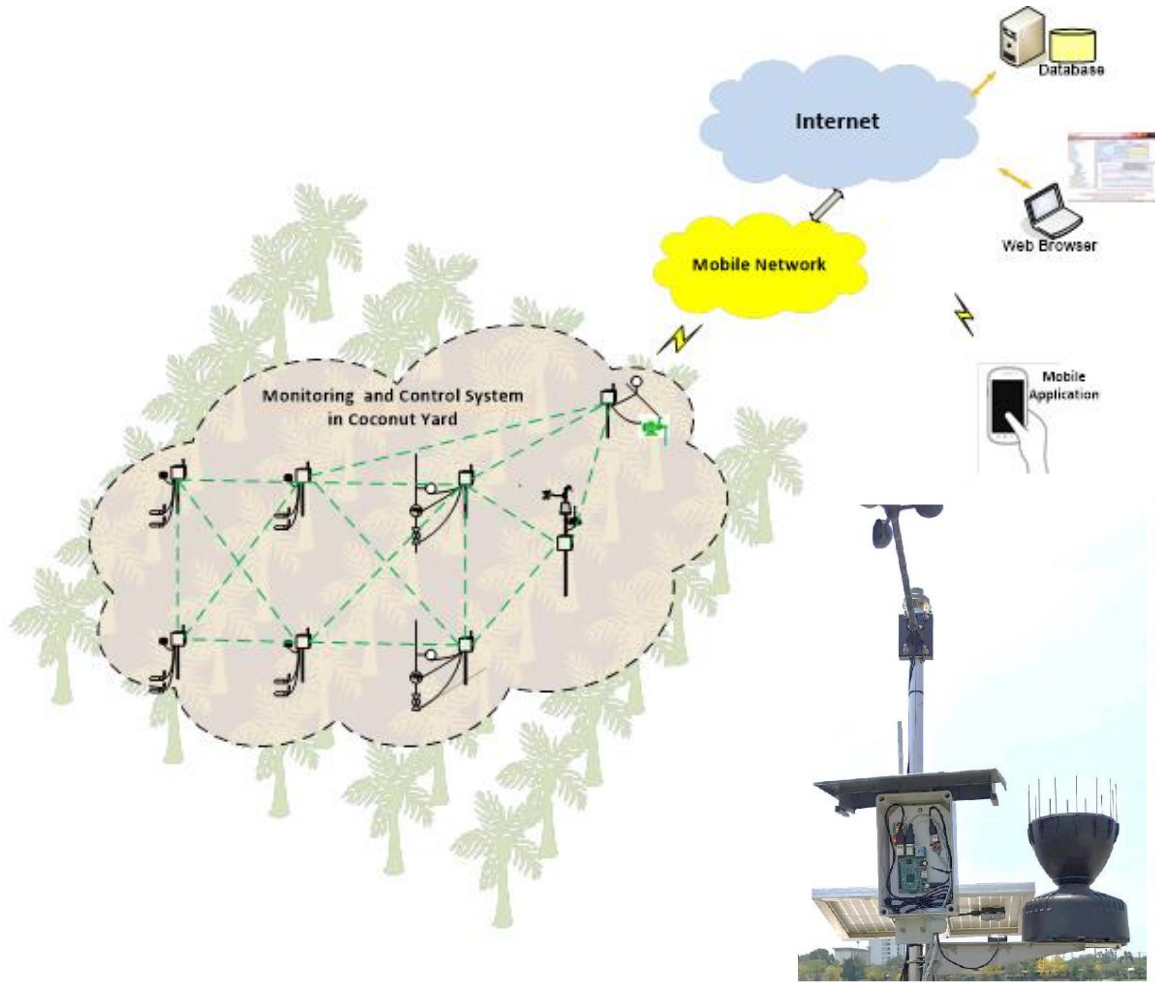
3 years (Jun 2018 – **May 2022**) (Request for 1-year extension)

Project Budget:

116,000 USD

System Overview

Experiments at Kehakaset Coconut Farm, Pathum Thani, Thailand



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

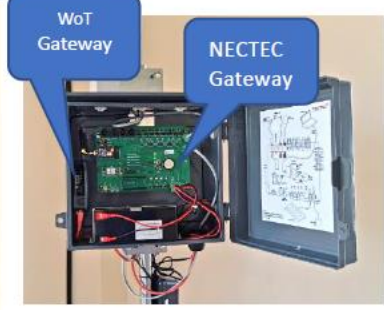
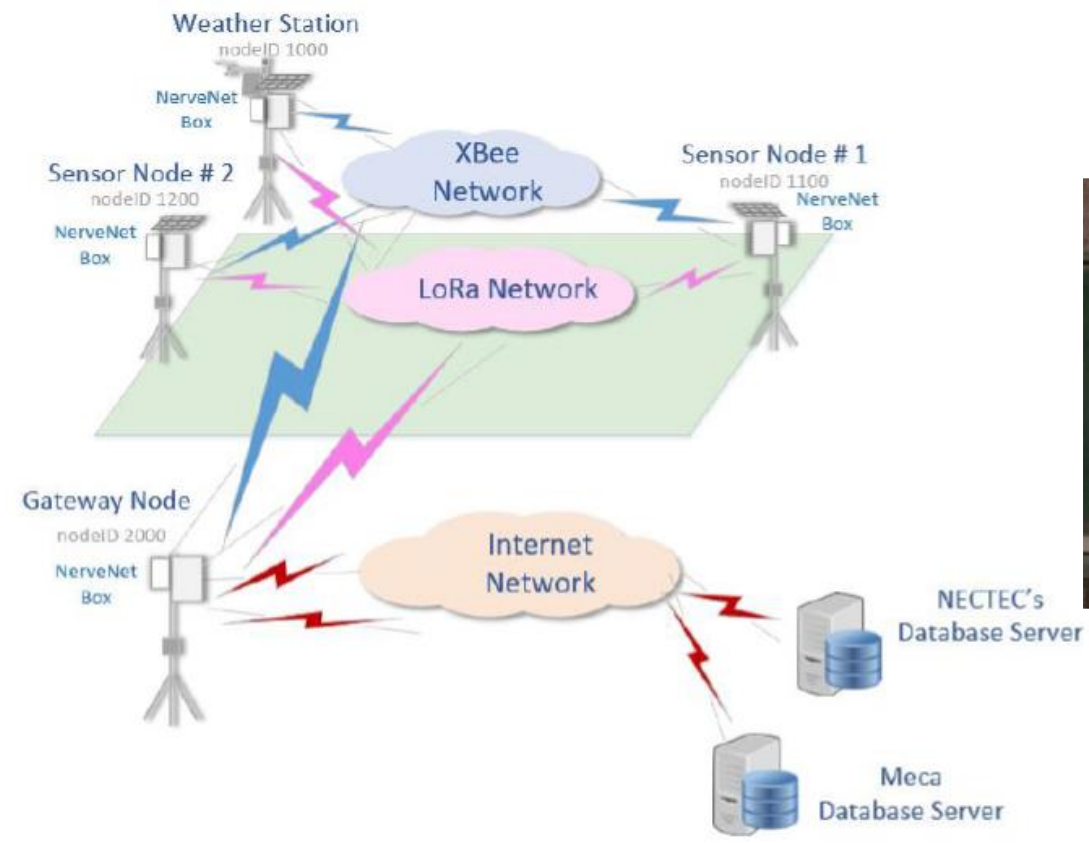
2021

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



2022

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

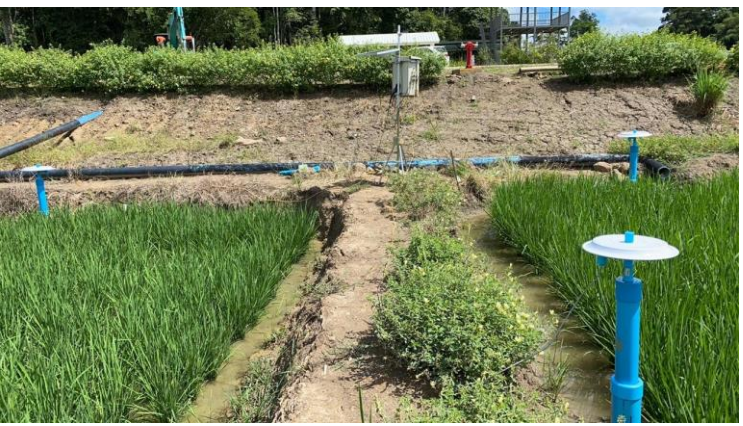


Project Activities in Brunei Darussalam

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

Revisions: early June 2021

Deployed new version with improved WS board



Meeting ID: 892 9202 7614
Passcode: 911356

NICT National Institute of Information and Communications Technology

ASEAN IVO

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

Session 1: Brunei's Paddy Industry

- Prof Dr Hjh Zohrah Hj Sulaiman, Vice Chancellor, UTB, Guest of Honor
- Dyq Khairumaisa Haji Omar, DAA
- Puan Hjh Rosita Hassan, BSP
- Nurzuraine Hj Kamartuzaman, UBO
- Dr Wida Susanty Hj Suhaili, UTB
- Dr Au Thien Wan, UTB

Session 2: International Best Practices (IBP)

- Mr Masugi Inoue, Director of Global Alliance Dept, NICT JAPAN
- Theodoro Correa Jr., ZES IRRL

Session 3: Adoption of Technology

- Dr Sharifah Hafizah Syed Azzlin, UTM, Malaysia
- Udom Leavongphaiart, NECTEC, Thailand
- Dr Deemi Kumawan, UTB, Brunei
- Dr Saileem Nazamdeen, UTB

Session 4: Best Practices within the region

- Dr Wida Susanty Hj Suhaili, Country Lead SWS Paddy
- Prof Md Razli Ismail, UPM, Malaysia
- Dr Ir Basuki Sumiwanata, IPI, Indonesia
- Prof Morteza Jami, UTB, Brunei
- Dr Wida Suhaili, UTB

Bru-SWS Stakeholders

NECTEC **UTM** **IBTE** **AgroBIZ** **AITI** **ANIAN** **DST** **SPB** **BMD**

Project Activities in Myanmar

Meeting @UCSY



Green House Site @UCSY



Mango Farm site @on the way to Kungyangon



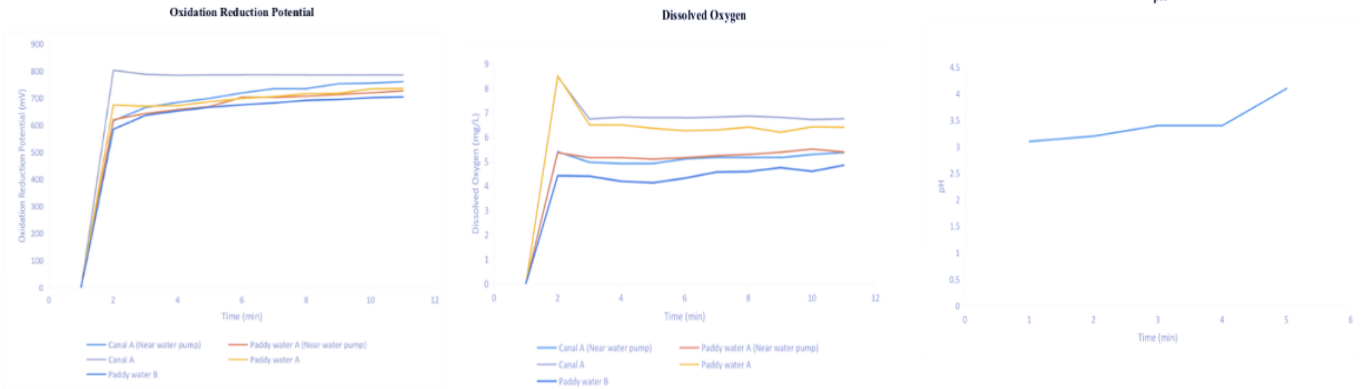
Meeting @Tawku Village



Paddy Field site @Khalauktayar Village



Paddy Field Water Quality Data Analysis Using ANOVA Approach



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

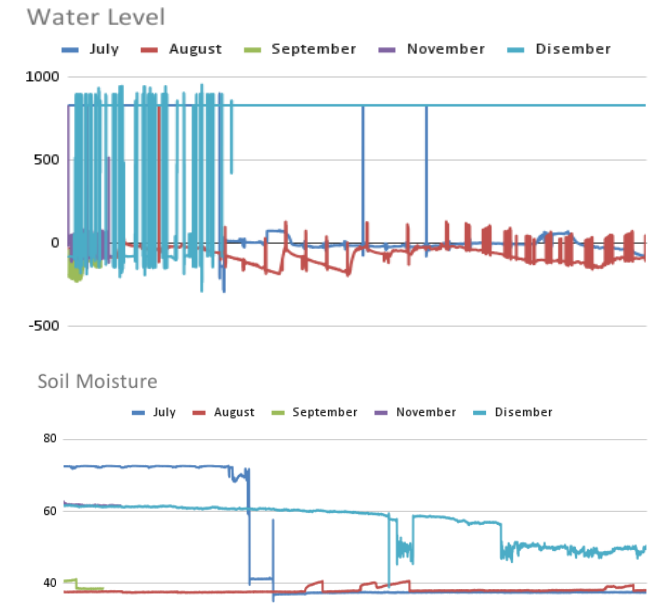


Site view

RICE-FIELD-MONITOR-1

- RICE-FIELD-MONITOR-1
 - .Sysinfo
 - Imang-Weather Station (NID 2000) (8192)
 - Wasan-Left node (NID 1100) (4352)
 - Drainage canal
 - Water level#1(300)
 - Left field
 - Soil moisture#1 (106)
 - Soil pH#2 (101)
 - Soil temperature#1 (104)
 - Water level#2 (301)
 - Water pH#1 (100)
 - Right field
 - Solar power supply
 - Wasan-Right node (NID 1200) (4608)
 - Wasan-Weather station (NID 1000) (4096)

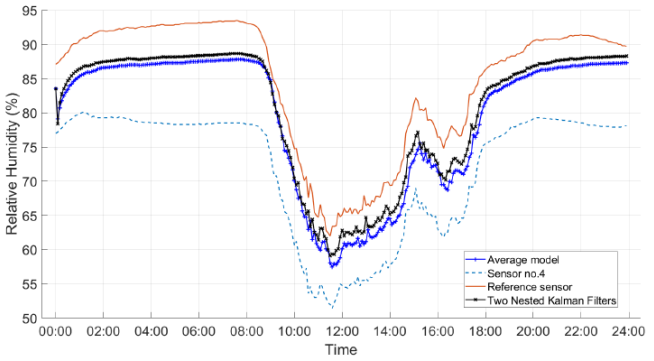
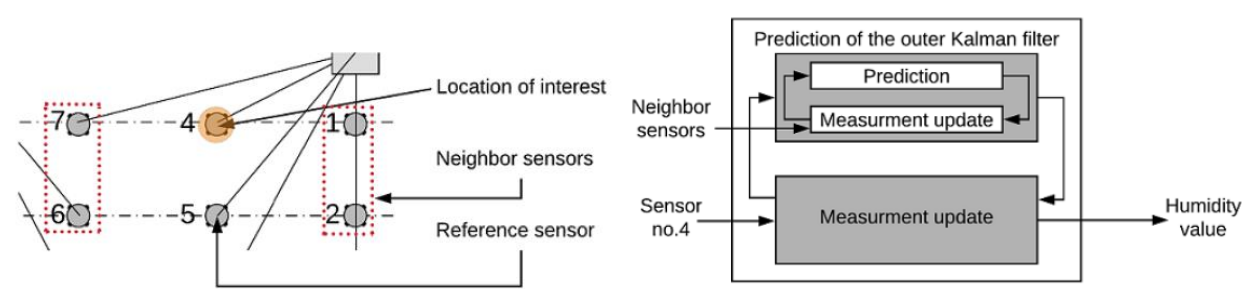
- Water pH
- Water level
- Soil temperature
- Soil pH
- Soil moisture



R&D results

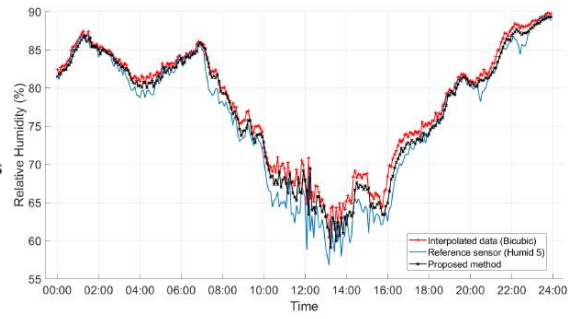
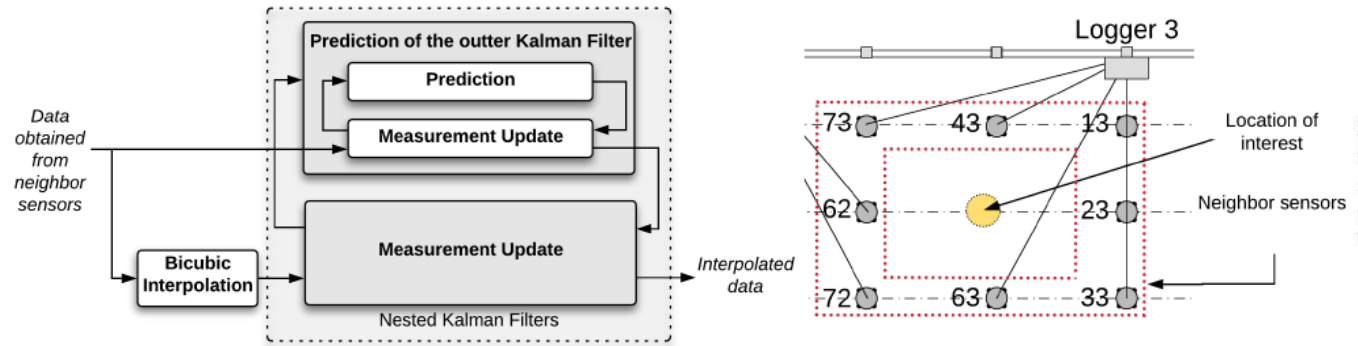
- Field prototypes of the smart watering system (tailor-made)
- Data
- Data analysis techniques

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



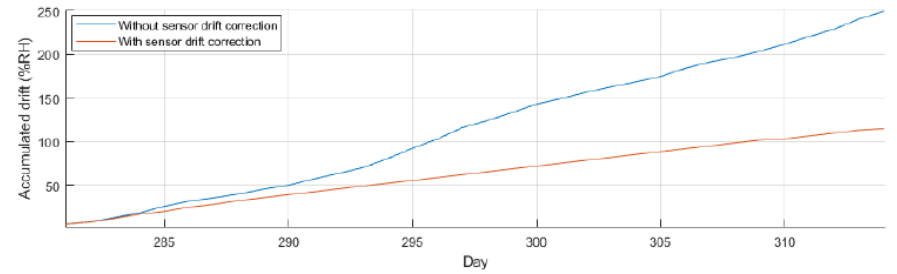
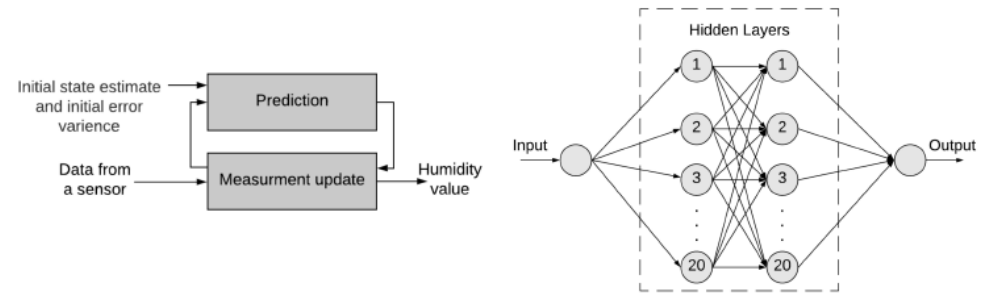
➤ RMSE was reduced by 22%

➤ 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%

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 Lewlompaisar 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 9 th 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. Rungprateepavorn ¹ , S. Keerativittayanun ¹ , and J. Karnjana ¹ | ¹ National Electronics and Computer Technology Center, ² Sirindhorn International Institute of Technology | The 27 th 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. Lewlompaisar 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 4 th International Conference on Computational Intelligence in Information System (CIIS 2020) | 25-27 January 2021 | UTB, Brunei Darussalam & Online |

Other presentations

BICET2021:
8 – 10 November 2021
IOT Adoption

BICET 2021
8th Brunei International Conference on Engineering and Technology (BICET 2021)
Organised by Faculty of Engineering, Universiti Teknologi Brunei
November 8-10, 2021, Brunei Darussalam

BEST TECHNICAL PRESENTATION AWARD
Presented to
Mohamad Zubair Arif Haji Shahrum, Dr Wida Susanty Haji Suhaili and Dr An Thein Win
for the paper titled
IoT Adoption to address water level issues for paddy plantation in IOTe_Agro
which was presented virtually during the conference

13 Nov 2021
Issue Date

(Prof. Dr. Mohammad Yeakub Ali)
Chairperson, Technical Committee,
BICET 2021

Presentations

Lesson learned in the adoption of technology in addressing climate change: Brunei's Perspective
Dr Wida Susanty Haji Suhaili
Deputy Director for Centre of Innovative Engineering (CIE),
School of Computing and Informatics,
Universiti Teknologi Brunei,
ASEAN Science & Technology Fellow 2019/2020

ASEAN IVO 2018
Smart Environment - NACP
Smart Watering System For Paddy

Presentations
24 – 25 Nov 2021

INTERNATIONAL CONFERENCE ON SUSTAINABLE AGRICULTURE AND BIOSYSTEM 2021
Faculty of Agricultural Technology – Andalas University
Campus Limau Manis Padang, West Sumatra, Indonesia
Website: <http://icsab.fabeta.unand.ac.id/>
Email: icsab@ae.unand.ac.id

INTERNATIONAL CONFERENCE ON SUSTAINABLE AGRICULTURE AND BIOSYSTEM 2021
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Dear Authors : Mhd Safwan Alhaman, Mohammad Naquiddin Hj Awg Rambli, Wida Susanty Haji Suhaili, Pg Seri Rahayu Pg Ya'akub, Denni Kurniawan, Murhamdillah Morni, Pg Rafidah Pg Hj Petra, Haji Ismit Hj Mohammad
Institutions : University of Brunei
ID Paper : S3-08

We are pleased to inform you that the committee has decided that your abstract entitled 'Development of Wireless Watergate Control System and Intergration with Sensor Nodes for Paddy Plantation' presentation at the International Conference on Sustainable Agriculture and Biosystem 2021, which will

INTERNATIONAL CONFERENCE ON SUSTAINABLE AGRICULTURE AND BIOSYSTEM 2021
Faculty of Agricultural Technology – Andalas University
Campus Limau Manis Padang, West Sumatra, Indonesia
Website: <http://icsab.fabeta.unand.ac.id/>
Email: icsab@ae.unand.ac.id

Dear Authors : Dr Wida Susanty Haji Suhaili
Institutions : University of Brunei
ID Paper : S3-07

We are pleased to inform you that your abstract entitled 'Adoption of Technology to improve self-sufficiency in paddy plantation in Brunei Darussalam: Challenges and Mitigation strategies for intermediate stakeholders' as a keynote presentation at the International Conference on Sustainable Agriculture and Biosystem 2021, which will be held in Padang, 24-25 November 2021. Congratulations!

BRUNEI INTERNATIONAL CONFERENCE ON ENGINEERING AND TECHNOLOGY 2021
"INNOVATION IN ENGINEERING AND TECHNOLOGY TOWARDS ENHANCING QUALITY OF LIFE AND SOCIETY."

Design of Floatation Water Gate For Paddy Field Irrigation

BY:
MOHAMAD NAQUIDDIN AWANG RAMBLI, SERI RAHAYU YA'AKUB, DENNI KURNIAWAN, WIDA SUSANTY SUHAILI, MURHAMDILAH MORNI, RAFIDAH PETRA AND ISMIT MOHAMMAD.

SUPPORTING PARTNERS:
Institution of MECHANICAL ENGINEERS
SPE
ice
IET The Institution of Engineering and Technology

Other presentations

Low-power Wireless Sensor Network Platform for a Smart Watering System and Its Applications

Jessada Karnjana, Yasunori Owada, *et al.*
 2021.2.4
 APAN51

Low-power Wireless Sensor Network Platform for a Smart Watering System and Its Applications & Irrigation 4.0

Jessada Karnjana
 2022.5.26
 AI & IoT Summit 2022



Demo of NerveNet/LoRa
 March 2019
 USM, Malaysia

- 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.

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**