[PROJECT TITLE: An Energy Efficient, Self-Sustainable, and Long Range IoT System for Drought Monitoring and Early Warning]
[OPEN WORKSHOP: Energy Efficient Sensors and RF Energy Harvesting for IoT Based Smart Monitoring Systems]

Report Form

I. Organizer:

Name: Assoc. Prof. Hoang Van Phuc
Institution: Le Quy Don Technical University, Vietnam

II. Program:

Date: 06-07, Aug. 2021
Venue: Convention Center, No. 236 Hoang Quoc Viet Str., Hanoi, Vietnam.

Program Agenda:

Date	August 06th, 2021	
Time	**Agenda**	**Speaker**
9:30 AM	Welcoming	Prof. Tran Xuan Nam, LQDTU
9:45 AM	The project achievement in 2020 and implementation plan for the fiscal year 2021	Prof. Hoang Van Phuc, LQDTU
10:30 AM	**Tea break**	
10:45 AM	Invited talk 1: Ambient RF Energy Harvester for Self-Powered IoT Device	Dr. Le Minh Thuy, Dinh Quang Minh, Nguyen Hong Quang, Vu Thi Nga (Hanoi University of Science and Technology, Vietnam)
11:45 AM	Discussion	Chair: Prof. Tran Xuan Nam, LQDTU
12:00 PM	Lunch	
1:30 PM	Organic pressure sensors for IoT systems	Prof. Dao Thanh Toan (UTC, Vietnam), Mr. Khong Duc Chien and Prof. Hoang Van Phuc (LQDTU, Vietnam)
2:30 PM	Invited talk 2: Advanced deep learning based vision techniques for IoT based monitoring	Dr. Nguyen Huu Hung (LQDTU) and Dr. Hoang Van Xiem (VNU)
3:30 PM	**Tea break**	

3:45 PM	A VCO-Based Analog-to-Digital Converter on Skywater 130nm for Internet-of-Things Applications	Duc-Manh Tran, Dr. Duy-Hieu Bui, Prof. Xuan-Tu Tran (VNU, Vietnam)
4:45 PM	Discussion and review about project progress	Chair: Hoang Van Phuc
6:00 PM	Dinner	
Date	**August 07th, 2021**	
Time	**Agenda**	**Speaker**
8:30 AM	PV and RF Hybrid Energy Harvesting Power Supply	Mr. Shuntaro Saku and Prof. Koichiro Ishibashi (UEC Tokyo, Japan)
9:00 AM	Some machine learning approaches for air quality prediction	Prof. Tran Duc Tan and Hoang Van Nhat (Phenikaa University, Vietnam)
9:45 AM	Steep SS "PN-Body Tied SOI FET" Diode for RF Energy Harvesting	Prof. Jiro Ida and Dr. Takayuki Mori (Kanazawa Institute of Technology, Japan)
10:15 AM	**Tea break**	
10:30 AM	Beat Sensors for monitoring CO2 to detect luck of ventilation in Covid-19 environment	Prof. Koichiro Ishibashi (UEC Tokyo, Japan)
12:30 AM	**Lunch**	
1:30-5:30 PM	River basin site investigating	15 members

III. Participants:

No.	Name	Organization	Itinerary
1	Hoang Van Phuc	LQDTU	04-08, August 2021
2	Tran Xuan Nam	LQDTU	04-08, August 2021
3	Nguyen Van Trung	LQDTU	04-08, August 2021
4	Nguyen Thuy Linh	LQDTU	04-08, August 2021
5	Nguyen Quoc Dinh	LQDTU	04-08, August 2021
6	Luong Duy Manh	LQDTU	04-08, August 2021
7	Dao Thanh Toan	UTC, Hanoi	04-08, August 2021
8	Ho Thanh Trung	UTC, Hanoi	04-08, August 2021
9	Bui Du Duong	NAWAPI, Hanoi	04-08, August 2021
10	Tran Duc Tan	Phenikaa Uni., Hanoi	04-08, August 2021
11	Hoang Van Nhat	Phenikaa Uni., Hanoi	04-08, August 2021
12	Le Minh Thuy	HUST, Hanoi	04-08, August 2021
13-18	06 officers of NAWAPI	NAWAPI, Hanoi	04-08, August 2021
19	Nguyen Huu Hung	LQDTU	04-08, August 2021
20	Tran Xuan Tu	VNU, Hanoi	04-08, August 2021
21	Bui Duy Hieu	VNU, Hanoi	04-08, August 2021

22	Diem Cong Hoang	HUMG, Hanoi	04-08, August 2021
23	Pham Thi Huyen	UTC, Hanoi	04-08, August 2021
24	Nguyen Huu Thang	VNPT Technology	04-08, August 2021
25	Bui Van Viet	ASIC Technologies	04-08, August 2021
26	Hoang Dinh Dung	ASIC Technologies	04-08, August 2021
27	Hoang Van Xiem	VNU, Hanoi	04-08, August 2021
28-50	23 registered attendees	-	04-08, August 2021
51	Koichiro Ishibashi	UEC (Project member)	Online attendee
52	Jiro Ida	KIT (Project member)	Online attendee
53	Dao Van Lan	MU (Project member)	Online attendee
54	Shuntaro Saku	UEC, Japan	Online attendee
55	Mai Duc Tho	UEC, Japan	Online attendee
56	Tran Tuan Anh	UEC, Japan	Online attendee
57	Yuta Yoshikawa	UEC, Japan	Online attendee
58	Kosin Chamnongthai	KMUTT, Thailand	Online attendee
59	Taworn Benjanarasuth	KMITL, Thailand	Online attendee

IV. Summary of the activities corresponding to the objectives

1. Objective

The main objective of this workshop is to provide a forum for exchange of ideas and latest research results in advanced wireless communications, energy harvesting and IoT sensors for smart monitoring systems. The workshop is necessary for this project in gathering different experts to solve the issues of energy efficient sensors and RF energy harvesting for IoT based smart monitoring systems. Since the workshop is taken place in Hanoi, the capital of Vietnam, we have invited leading experts in the field of IoT sensors, RF energy harvesting, environment monitoring and drought management. The local companies in Hanoi have joined the workshop as well. Moreover, experts from univerisities have presented invited talks in this workshop. Especially, Prof. Koichiro Ishibashi from University of Electro-Communications, Tokyo, Japan has delivered a special tutorial on energy efficient sensors and RF energy harvesting for IoT based smart monitoring systems which helps Vietnamese researchers and students to improve their research ability and skills. The last but not least, we visit the river basin region during the workshop date to investigate the feasibility of the proposed IoT based monitoring system.

2. Activities corresponding to the objectives

a. Review the progress of project and exchange ideas and the latest research results in Energy Efficient Sensors and RF Energy Harvesting for IoT Based Smart Monitoring Systems:
   - Prof. Tran Xuan Nam gives welcome message of the workshop.
   - Assoc. Prof. Hoang Van Phuc presents project achievement in 2020 and

implementation plan for the fiscal year 2021;

- Dr. Le Minh Thuy, Dinh Quang Minh, Mr. Nguyen Hong Quang and Ms. Vu Thi Nga from HUST present the invited talk on Ambient RF Energy Harvester for Self-Powered IoT Device;
- The project members discuss how to employ Ambient RF Energy Harvester for drought monitoring system in this project. The conclusion is that it should be combined with other supply sources such as PV and battery;
- Prof. Dao Thanh Toan (UTC, Vietnam) and Mr. Khong Duc Chien (LQDTU) give an invited talk about Long range communications for IoT based smart monitoring systems;
- Dr. Luong Duy Manh presents about Organic pressure sensors for IoT systems;
- Dr. Nguyen Huu Hung (LQDTU) presents the invited talk on advanced deep learning based vision techniques for IoT based monitoring systems;
- Mr. Duc-Manh Tran, Dr. Duy-Hieu Bui, Prof. Xuan-Tu Tran (VNU, Vietnam) give an invited talk: "A VCO-Based Analog-to-Digital Converter on Skywater 130nm for Internet-of-Things Applications", which followed by the discussion and review about project progress chaired by Assoc. Prof. Hoang Van Phuc;
- Regarding to sustainable energy source for IoT systems, Mr. Shuntaro Saku and Prof. Koichiro Ishibashi (UEC Tokyo, Japan) present about PV and RF Hybrid Energy Harvesting Power Supply.
- Prof. Tran Duc Tan and Hoang Van Nhat (Phenikaa University, Vietnam) have presented some machine learning approaches for air quality prediction; then, Prof. Jiro Ida and Dr. Takayuki Mori (Kanazawa Institute of Technology, Japan) talked about steep SS "PN-Body Tied SOI FET" diode for RF energy harvesting.
- Especially, Prof. Koichiro Ishibashi (UEC Tokyo, Japan) gives the special tutorial on "Beat Sensors for monitoring CO2 to detect luck of ventilation in Covid-19 environment".

b. Discuss about the future plan of the project: Members from Vietnam, Thailand and Japan have discussed about the results and future plan as well as the feasibility of proposed systems in both Vietnam and Thailand. Assoc. Prof. Hoang Van Phuc concluded the discussions and the follow-up plan. In conclution, the project has achieved promising results despite of COVID-19 issues. In the following steps, the hardware system (sensors, power supply modules, connectivity modules) will be completed. Then, we will develop the web-based application for the real time drought monitoring and warning.

c. Visit the river basin region during the workshop date to investigate the feasibility of the proposed IoT based monitoring system: Members of the project team (Prof. Hoang Van Phuc, Dr. Nguyen Van Trung, Dr. Nguyen Thuy Linh, Prof. Nguyen Quoc Dinh, Prof. Dao Thanh Toan, Dr. Bui Du Duong and 9 students) have visit the Red river basin region in Hung Yen city (65 km from the workshop venue) during the workshop date to investigate the feasibility of the proposed IoT based monitoring system. Specifically, we have performed the experiments for LoRa communications. The results have clarified the feasibility of deploying IoT based monitoring system with LoRa communications in which the communication range can be achieved at least 2.5 km. Babsed on this result, we are considering to add one pilot site in this area.

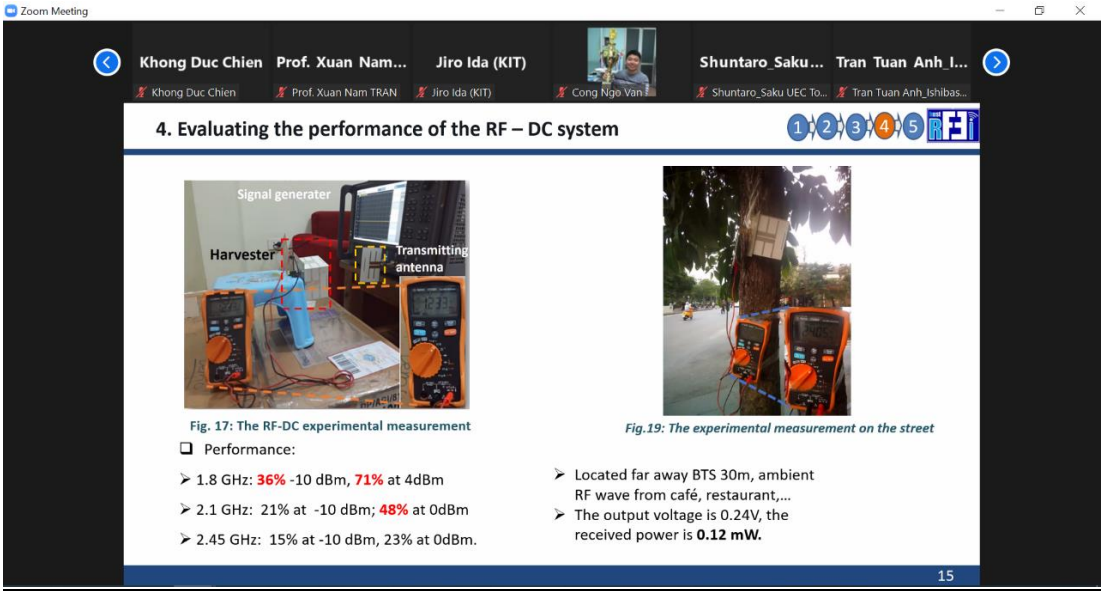
3. Detailed changes from the initial proposal:

In general, the content of the workshop is unchanged. We only updated the titles of the talks and add one more talk of UEC team on “PV and RF Hybrid Energy Harvesting Power Supply”. Due to COVID-19 pendamic, the workshop date was changed and we used separate rooms for groups of participants for safety.

V. Others

The workshop related pictures as below:

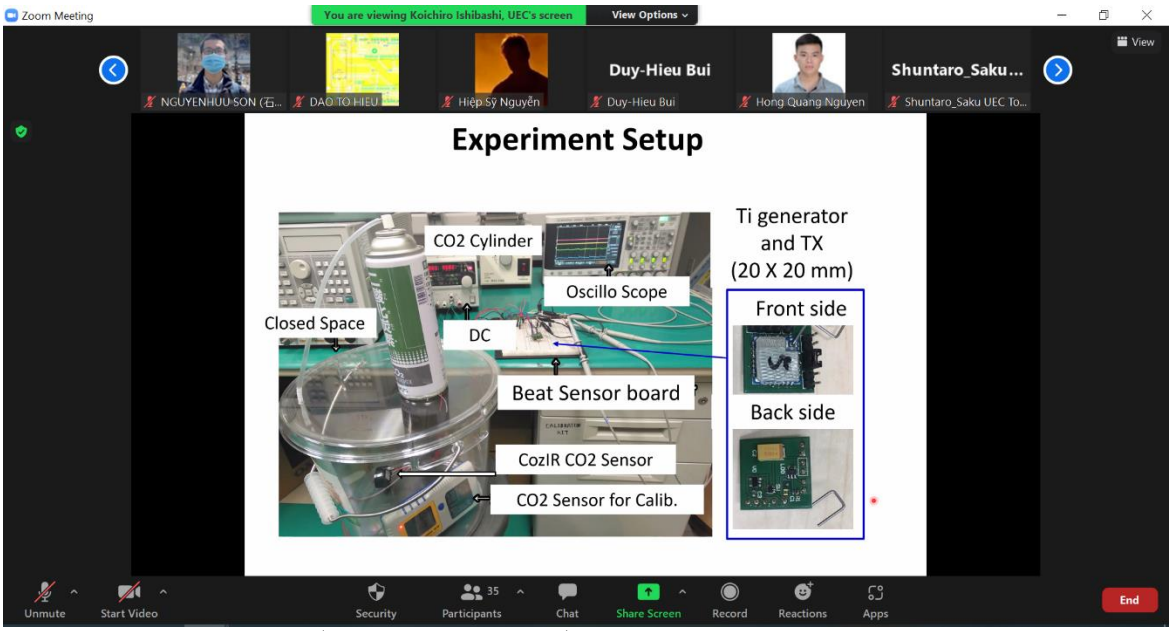
Prof. Tran Xuan Nam gives welcome message of the workshop.



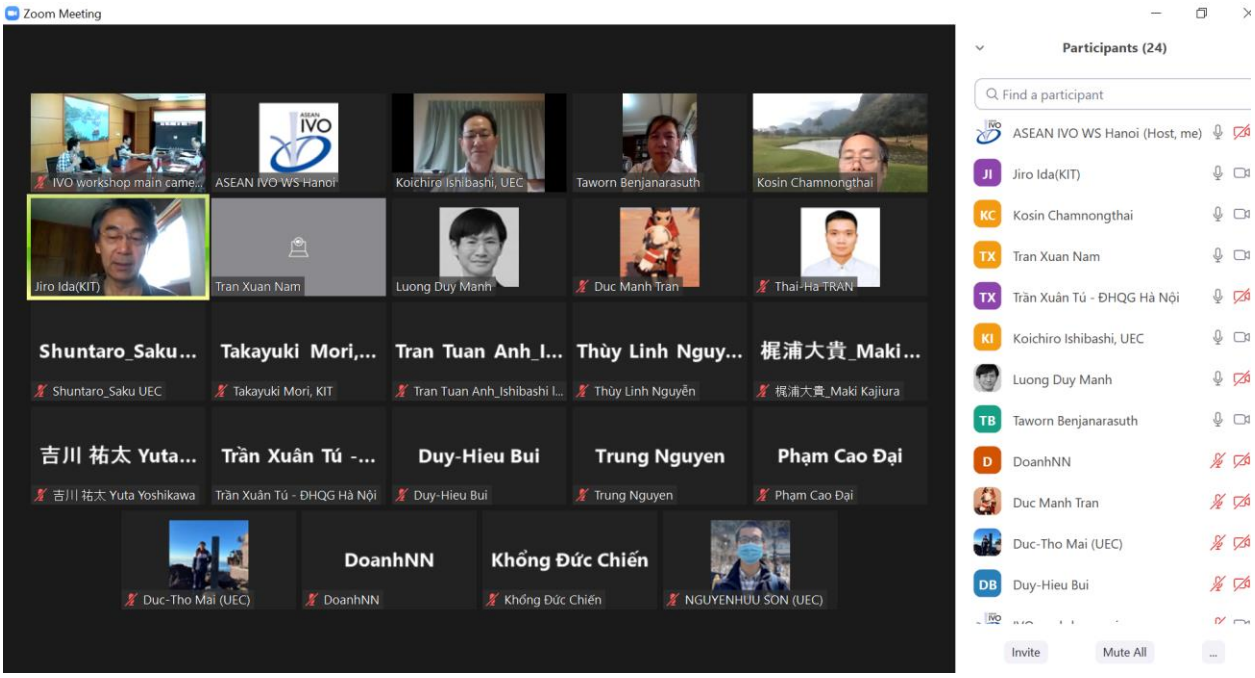
Dr. Le Minh Thuy, Dinh Quang Minh, Mr. Nguyen Hong Quang and Ms. Vu Thi Nga from HUST present the invited talk on Ambient RF Energy Harvester for Self-Powered IoT Device.

Prof. Jiro Ida and Dr. Takayuki Mori (Kanazawa Institute of Technology, Japan) talked about steep SS “PN-Body Tied SOI FET” diode for RF energy harvesting

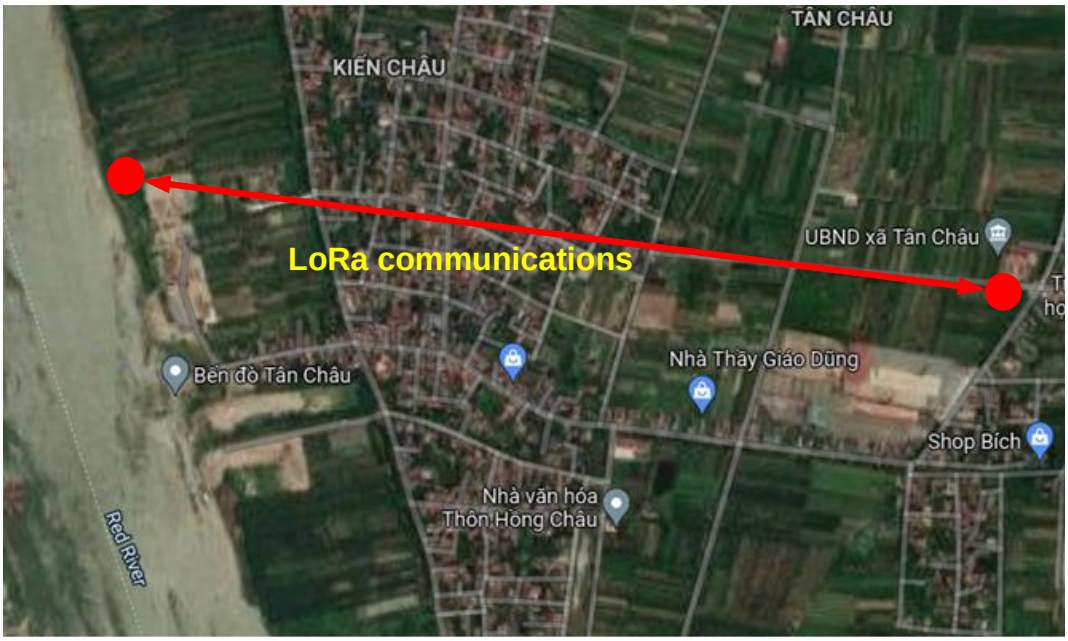
Mr. Shuntaro Saku and Prof. Koichiro Ishibashi (UEC Tokyo, Japan) present about PV and RF Hybrid Energy Harvesting Power Supply.



Prof. Koichiro Ishibashi (UEC Tokyo, Japan) gives the special tutorial on "Beat Sensors for monitoring CO2 to detect luck of ventilation in Covid-19 environment".



Discussion about the project results and future plan.



Site visit at the Red river basin region in Hung Yen city for experiments with LoRa communications.