Visual IoT Network for Environment Protection and Disaster Prevention

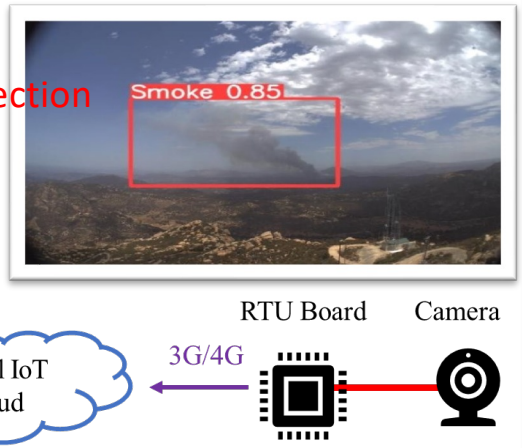
Background :

One of the leading causes of air pollution problems (e.g., PM2.5) is a forest fire. It is found that about 92% of burned area in Chiang Mai are in the conservation forest and national park. Furthermore, with the problem of high steep mountainous terrain in conservation and national parks and insufficient patrol staff, it is very difficult to do the effective monitoring and firefighting task with a quick response. Using Visual IoT in the forest fire monitoring system will increase the ability to accurately assess and provide information about the situation of the scene quickly. In this project, Visual IoT will be used iin order to assess the situation of forest fire.

Targets:

- System of visual IoT cameras with transmission modules
- Algorithms for forest fire detection
- Data visualization

Algorithms for forest fire detection



System of visual IoT cameras with transmission modules

Speaker:

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National Electronics and Computer Technology Center, Thailand

Visual IoT Network for Environment Protection and Disaster Prevention

Project Members :

National Institute of Information and Communications Technology (NICT)
Mapua University
University of Computer Studies, Yangon (UCSY)
National University of Laos (NUOL)
National Electronics and Computer Technology Center (NECTEC)
Sirindhorn International Institute of Technology (SIIT)
King Mongkut's Institute of Technology Ladkrabang (KMITL)

Project Duration : June 2022 – May 2025 (2 years + 1 year extension)

Project Budget: 40,000 USD/year (Total 80,000 USD)

Project Activities

- To perform final checking of 5 units of Visual IoT system
- To have meeting with each sub-district and inform the method to monitor taken images

To organize a meeting for UCSY and NUOL team supported by NECTEC team and NICT team in order to configure the Visual IoT system including microcontroller (RasPi-4) board, IP camera and communication channel. The configuration of the system to upload and download the taken images to NICT server has been also investigated.

On-line meeting with Mapua Malayan Colleges Mindanao (new member) about system installation at Mt. Apo

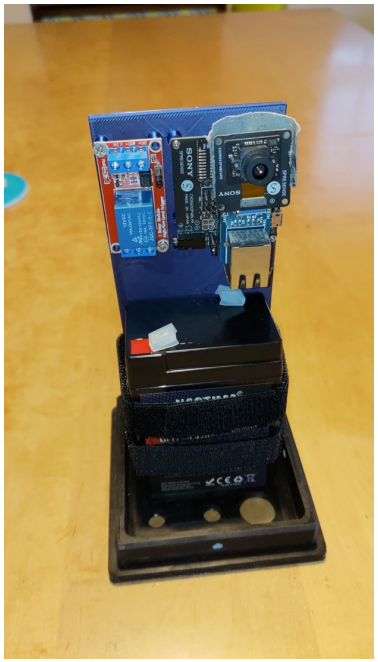
R&D results : Target #1 – System of Visual IoT camera with transmission modules

Viaul IoT system installed at NICT

- The first prototype based on Raspberry Pi 4 has been developed by NICT team.
- Powered by solar panel + battery and installed on rooftop (outdoor).

- The second prototype based on ESP 32 has been also developed to reduce power consumption and increase system reliability.
- The system has been tested in Japan.
- The quality (resolution) of taken image is not satisfactory.

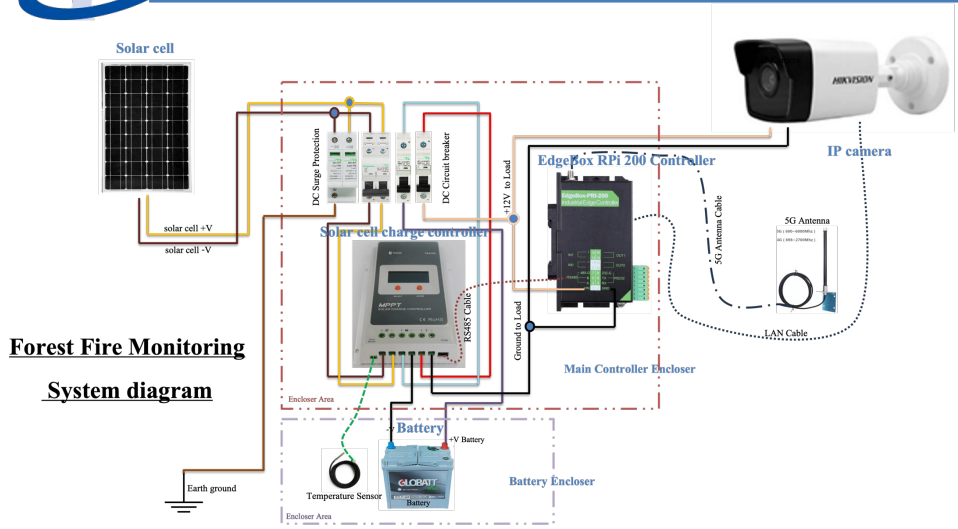
ESP 32 based system



SONY SPRESENSE system

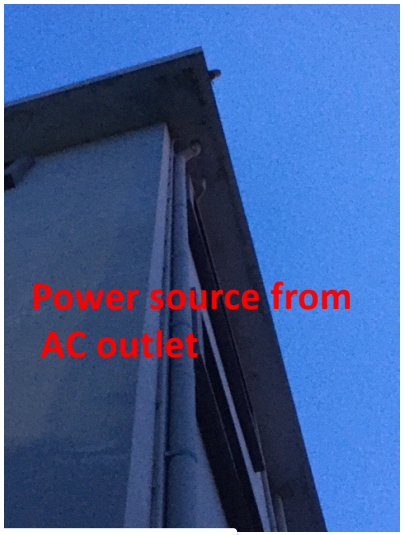
- The third prototype based on Sony's CXD5602 micro-controller has been developing by NICT team.
- The system is now testing in Japan and will be tested in ASEAN member countries.

R&D results : Target #1 – System of Visual IoT camera with transmission modules



System diagram (Modified by NECTEC)

Visual IoT & transmit modules

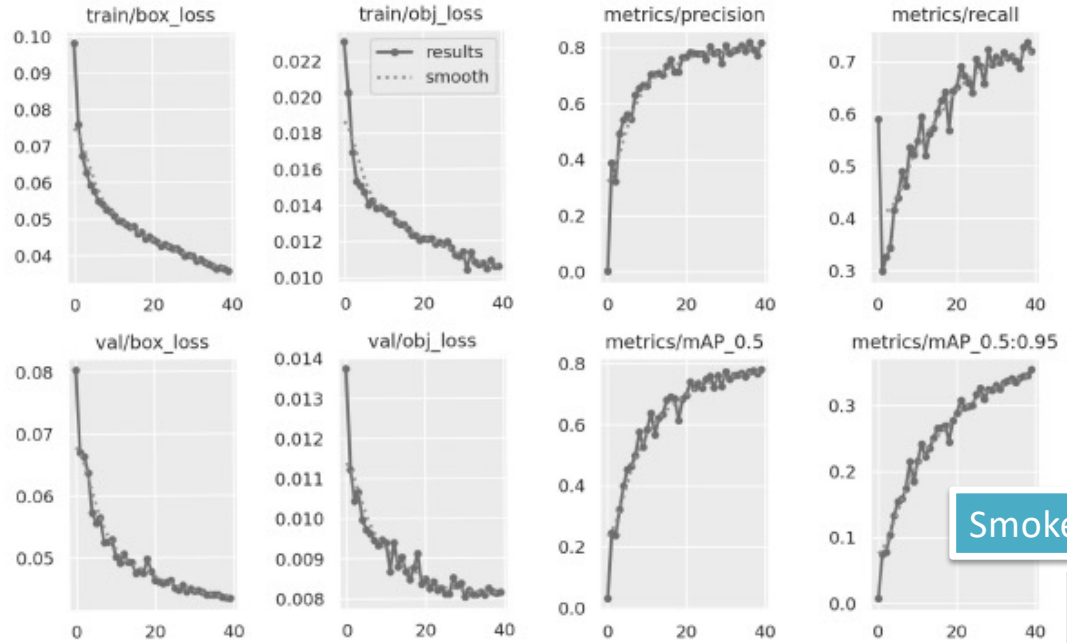


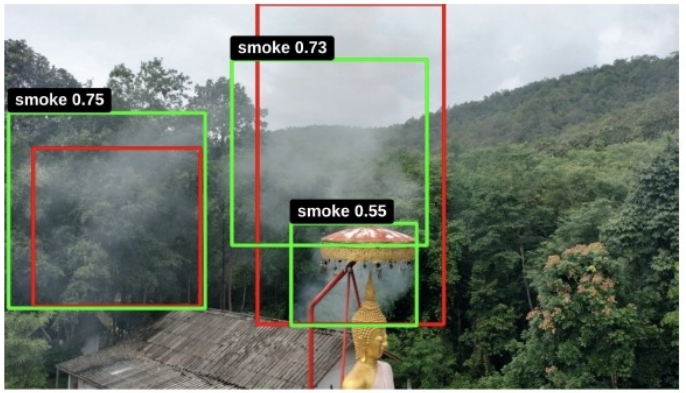
Locations of installation

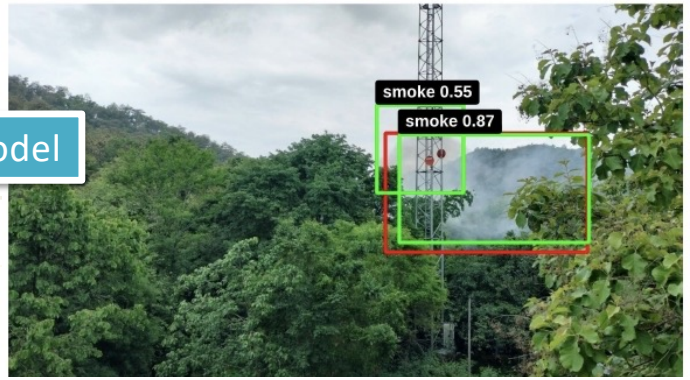
- **The Visual IoT system have been installed in Chiang Mai, Thailand (5 units) and Nay Pyi Taw, Myanmar (3 units). Another 2 units have been purchased and will be installed at Sang Tong district, Vientiane, Lao PDR by this October.**

Example of taken images (in Chaing Mai, Thailand)

R&D results : Target #2 – Algorithm for forest fire detection







Smoke Detection Model

YOLOv5

Round	Precision	Recall	$mAP_{0.5}$	$mAP_{0.5:0.95}$	F1-score
1	**0.8171**	0.7198	**0.7809**	**0.3547**	**0.9688**
2	0.7749	**0.7228**	0.7693	0.3435	0.9605
3	0.8055	0.7207	0.7772	0.3332	0.9700
4	0.7631	0.6948	0.7364	0.3359	0.9616

Metrics of 4-fold cross validation

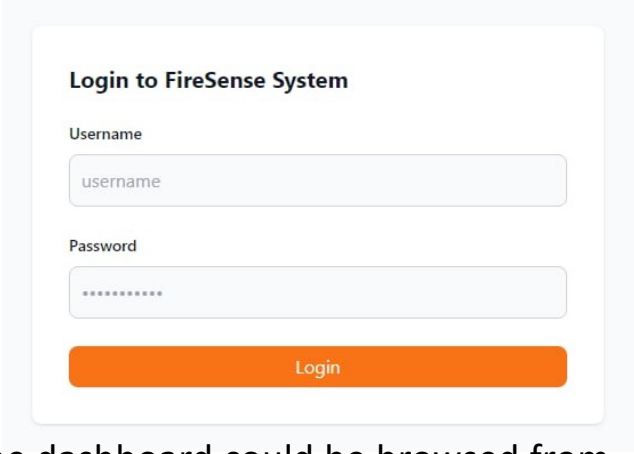
$$F_1 = 2 \cdot \frac{\text{precision} \cdot \text{recall}}{\text{precision} + \text{recall}} = \frac{\text{TP}}{\text{TP} + \frac{1}{2}(\text{FP} + \text{FN})}$$

TP = number of true positives

FP = number of false positives

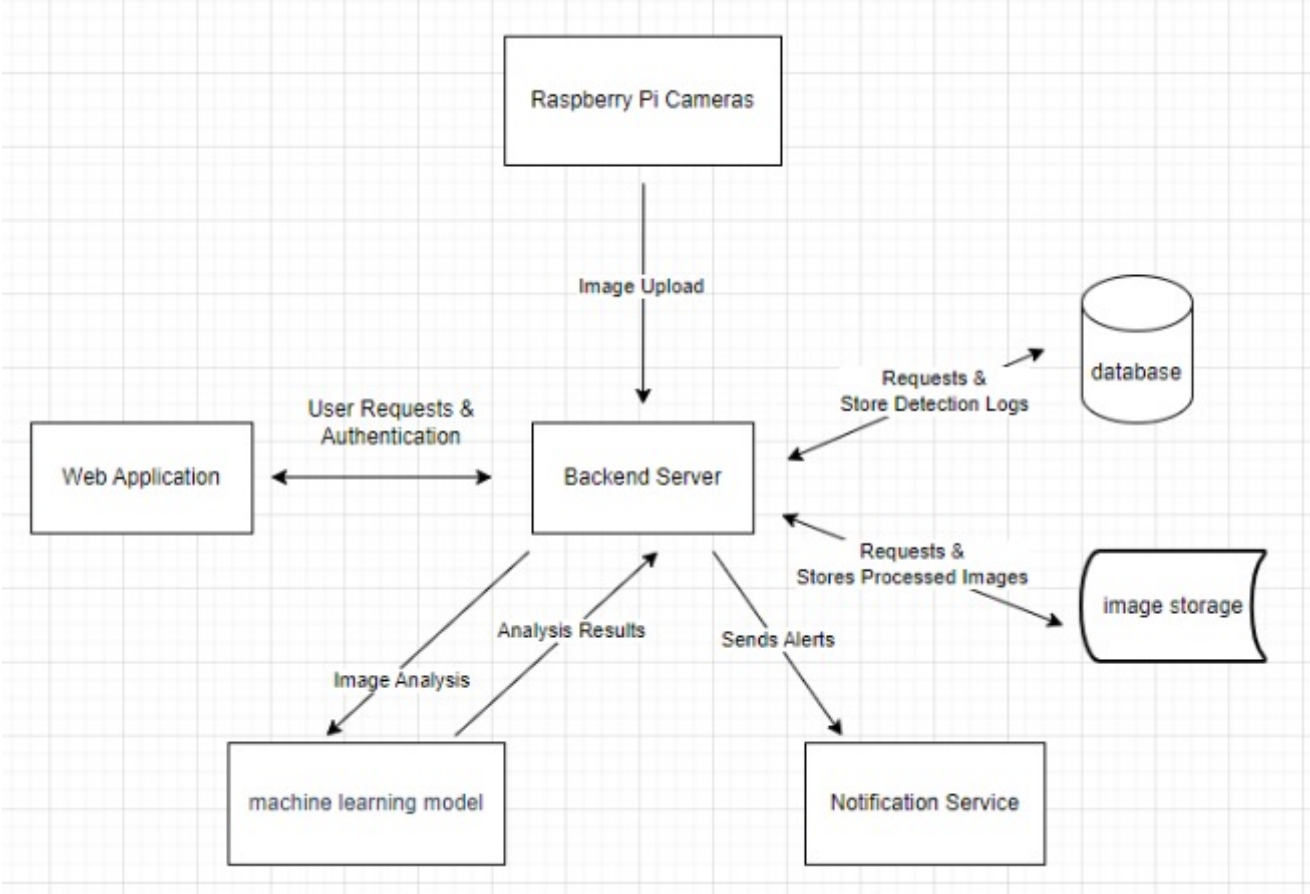
FN = number of false negatives

R&D results : Target #3 – Data visualization

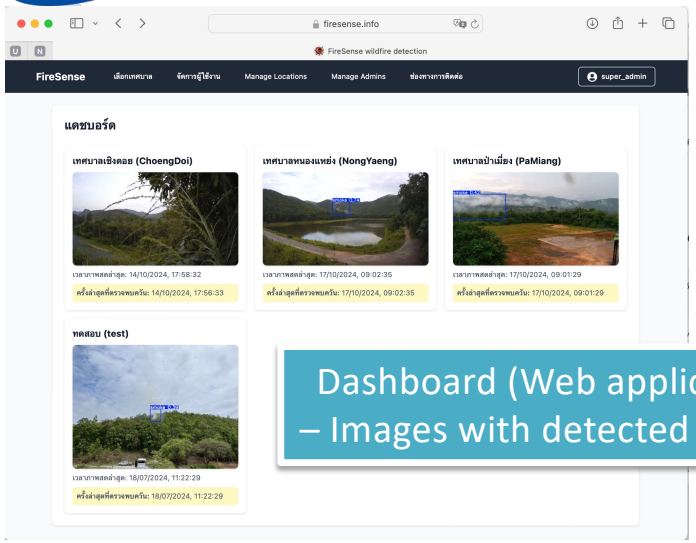


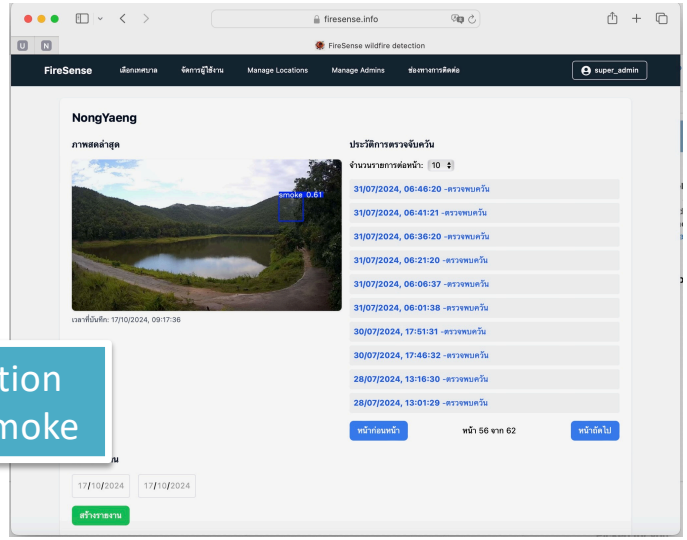
The dashboard could be browsed from the web site (https://firesense.info)

- Super admin (NECTEC team)
- Admin (Representatives of sub-districts and authorized peoples.
- User

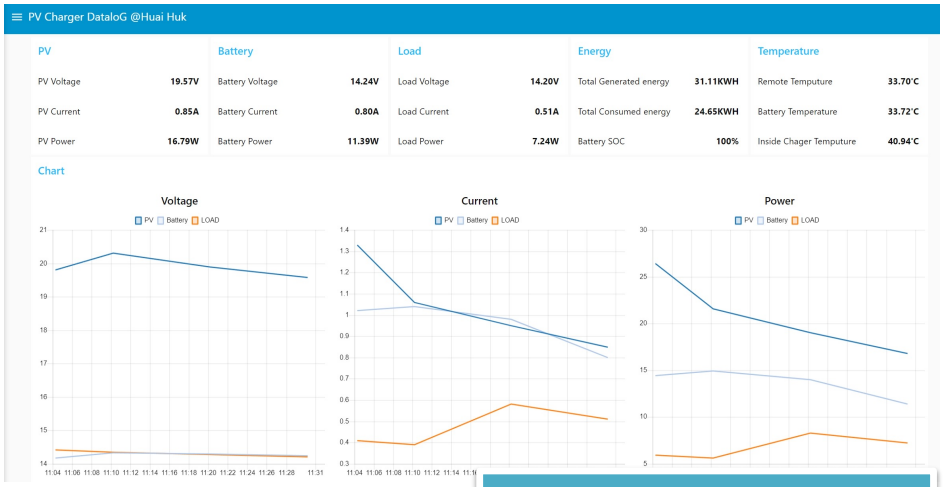


R&D results : Target #3 – Data visualization



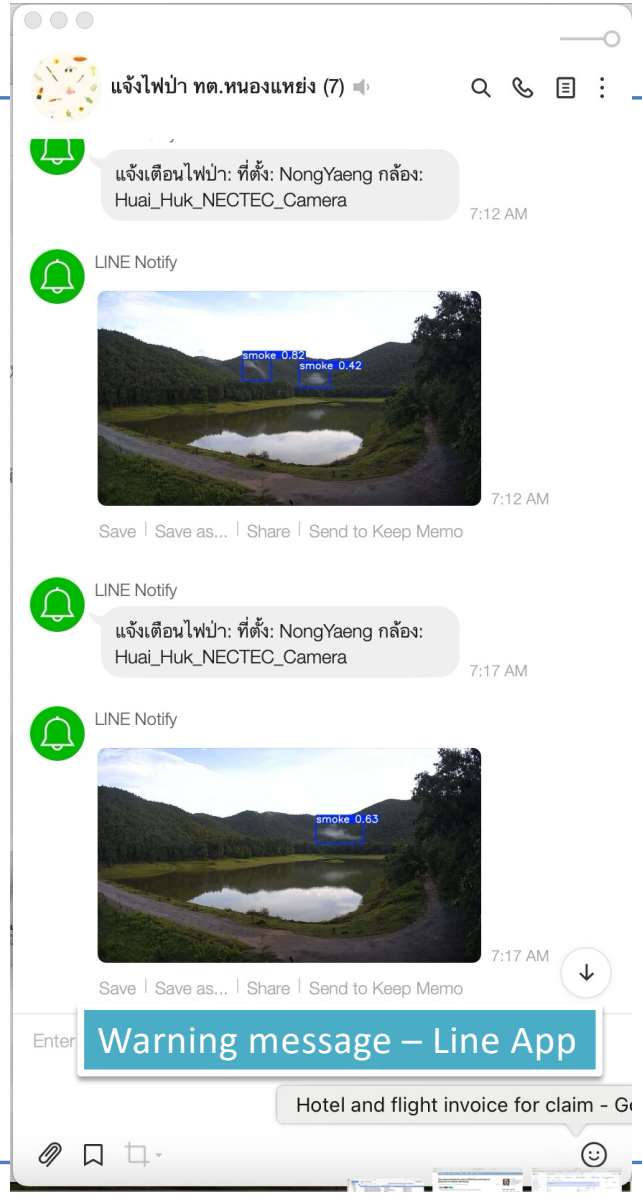


Dashboard (Web application – Images with detected smoke



Dashboard – Solar panel

- The location of camera in each sub-district could be selected and
- The voltage, current and power of solar panel and battery are also monitored.
- The waring message of smoke detection is sent to local government via Line Application.



Warning message – Line App

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	Forest Fire Detection and Warning System for Disaster Prevention	Ye Naing and Thin Lai Lai Thein	UCSY	International Conference for Computer Applications	Feb 27-28, 2023	Yangon, Myanmar
2	Vision System for Recognition of Water Level, Rain Water, and Flood Detection	J. D. Cadion, C. Lacandora, J. D. Cruz, J. Kanjana and K. Tungpimolrut	Mapua University, NECTEC	IEEE 14th Control & System Graduate Research Colloquium	Aug 5, 2023	Shah Alam, Malaysia
3	FireSpot: A Database for Smoke Detection in Early-stage Wildfires	N. Pornpholkullapat, W. Phankrawee, P. Boondet, T. L. L. Thein, P. Siharath, J. D. Cruz, K. Murata, K. Tungpimolrut and J. Karnjana	NECTEC, SIIT, CMU, UCSY, NUOL, Mapua University, NICT	The 18th International Joint Symposium on Artificial Intelligence and Natural Language Processing	Nov 27-29, 2023	Bangkok, Thailand
4	Visual IoT System for Smore/ Fire Detection in Chiang Mai (Thailand)	K. Tungpimolrut	NECTEC	International Conference for Computer Applications	Mar 16, 2024	Yangon, Myanmar

Societal Impact:

Dataset construction

Field experiment for developing an image-based dataset have been conducted in all 3 targeted sub-districts in Chiang Mai, Thailand. The dataset is open for project member to access.

Our dataset

Area	Location	Total number of fire spots	#Photos taken
1. Huai Huk	lat 18.9245582, long 99.094015	8	4,355
2. Pa Maing	lat 18.9145094, long 99.2284893	7	3,977
3. Doi Koo 1	lat 18.8854613, long 99.1708773	5	2,580
4. Doi Koo 2	lat 18.885279, long 99.1706582	4	1,887
5. Pang Sak	lat 18.9026969, long 99.203065	5	1,843
Total number of photos taken in this field experriment			14,642

Conclusion:

Activities that have been done so far in 2024 are summarized as follows.

- **Workshop/Training Meetings**: 2 workshops, 2 sites
  - Myanmar, Lao PDR
- **Field experiments:** 3 field experiments, in 3 countries
  - Chiang Mai (Thailand) – Nong Yang, Pa Miang and Choeng Doi sub-district (5 cameras/locations in 3 sub-districts)
  - Nay Pyi Taw (Myanmar) – 3 camera/locations
  - Vientiane (Lao PDR) – 2 camera/locations
- **Perform the development of (1) System of Visual IoT camera with transmission modules (2) Algorithms for forest fire detection and (3) Data visualization as planned.**

Future works:

	2023		2024					
	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Equipment installation in Lao PDR and the Philippines								
Improve Machine Learning algorithm								
Modify data visualization platform								
Data collecting and system verification								
Technical papers preparation & submission								
Final report								