FireSpot

A Database for Smoke Detection in Early-stage Wildfires

28 November 2022

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01

Introduction

Wildfire Effect:

- Caused PM 2.5
- Risk to local living organism
- Challenging to handle and manage
- Using Lookouts are insufficient
- Our purpose is to solve this problem by detecting the wildfire in their early stage

Wildfire Detection Technologies

aerial-based

- Can access any inaccessible site
- limited by workforce budget and
- not practical for real-time monitoring.

Satellite-based

- can cover a large area but has less temporal and spatial resolution.

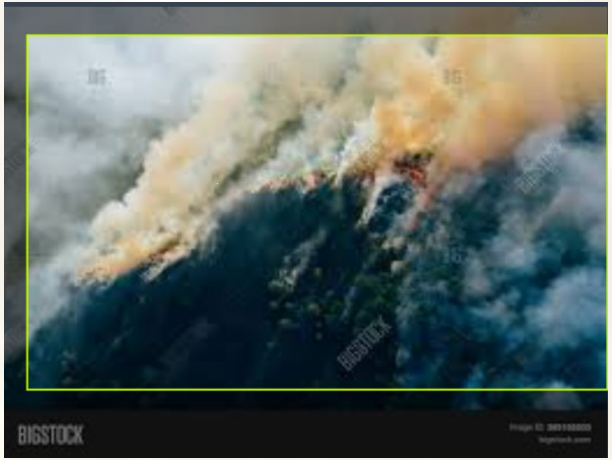
terrestrial-based

- most efficient in terms of accuracy and response time
- Cover mid to large area

02

Dataset Construction

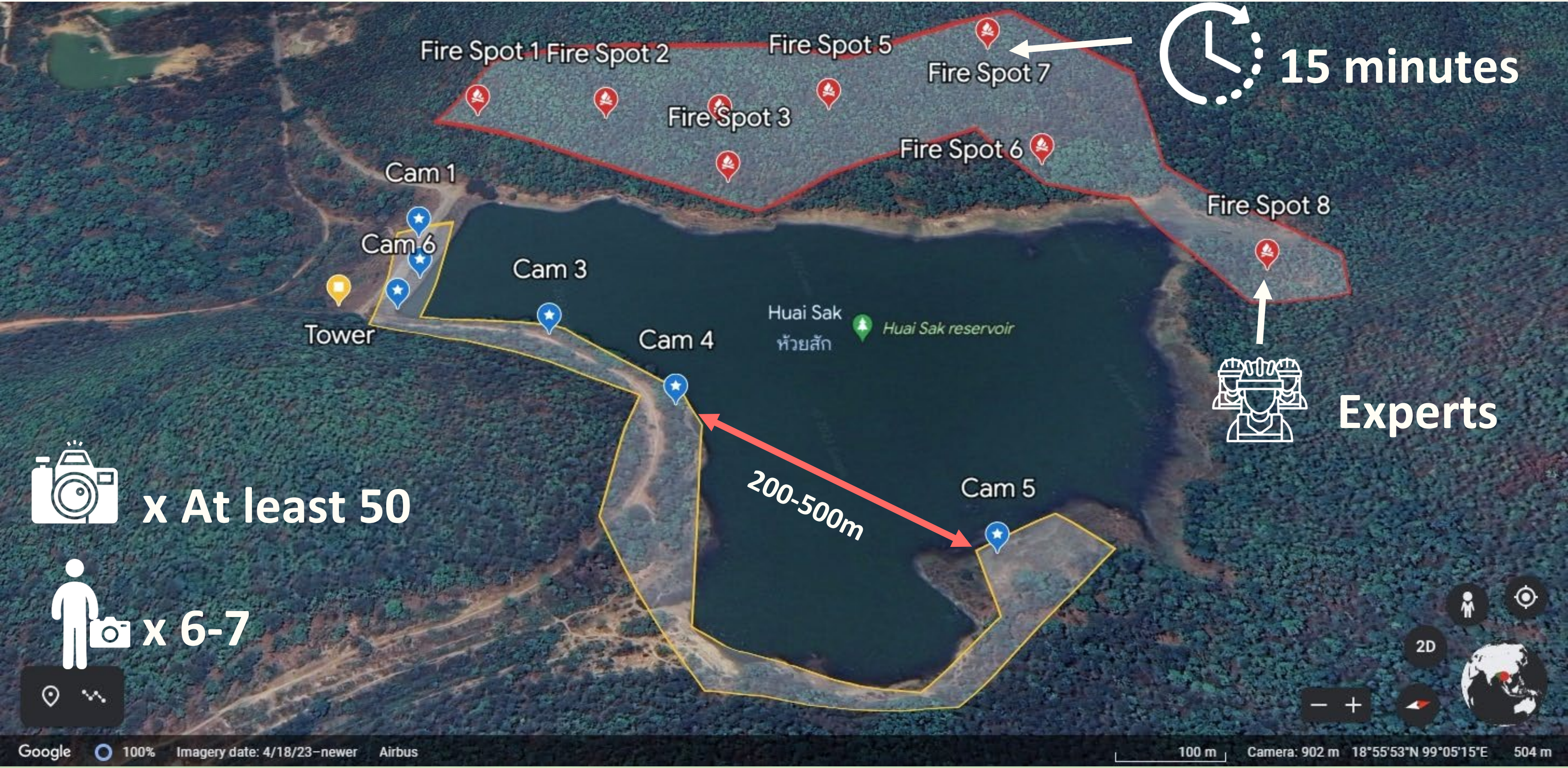
Example Of Available Datasets



STEP 1 : Choosing Location

*activities were conducted fro
the 6th to the 16th of June, 202

- local government staff responsible for managing and handling wildfires in the area listed locations where actual wildfires had occurred

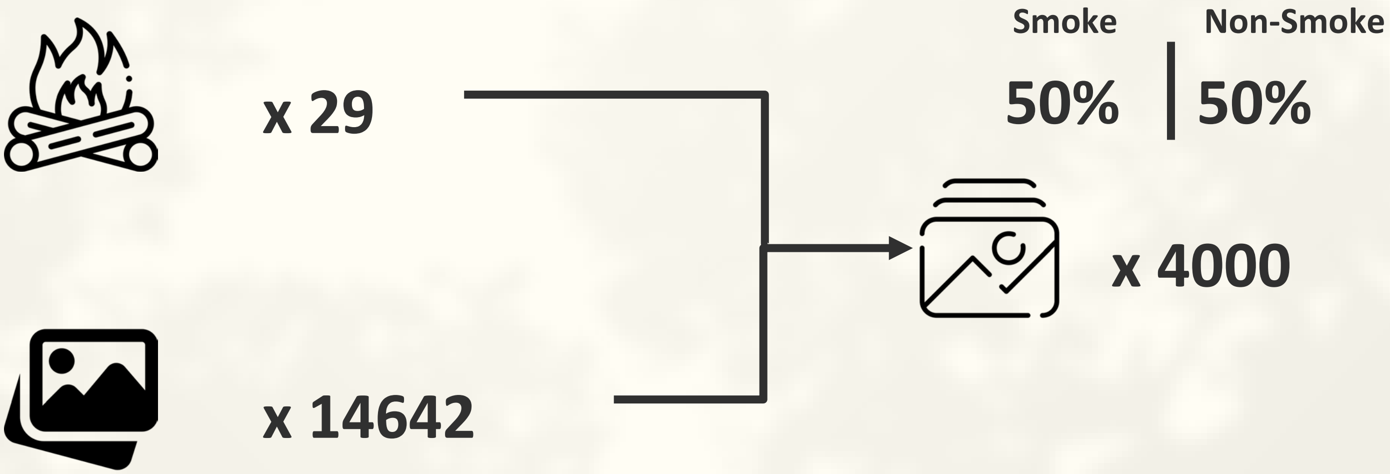

Fire Spot 1
Fire Spot 2
Fire Spot 5
Fire Spot 7
Fire Spot 3
Fire Spot 6
Fire Spot 8
15 minutes
Cam 1
Cam 6
Cam 3
Tower
Huai Sak
ห้วยสัก
Huai Sak reservoir
Cam 4
Experts
200-500m
Cam 5
x At least 50
x 6-7
2D
Google
100%
Imagery date: 4/18/23–newer
Airbus
100 m
Camera: 902 m 18°55'53"N 99°05'15"E
504 m

Acquired Pictures Example





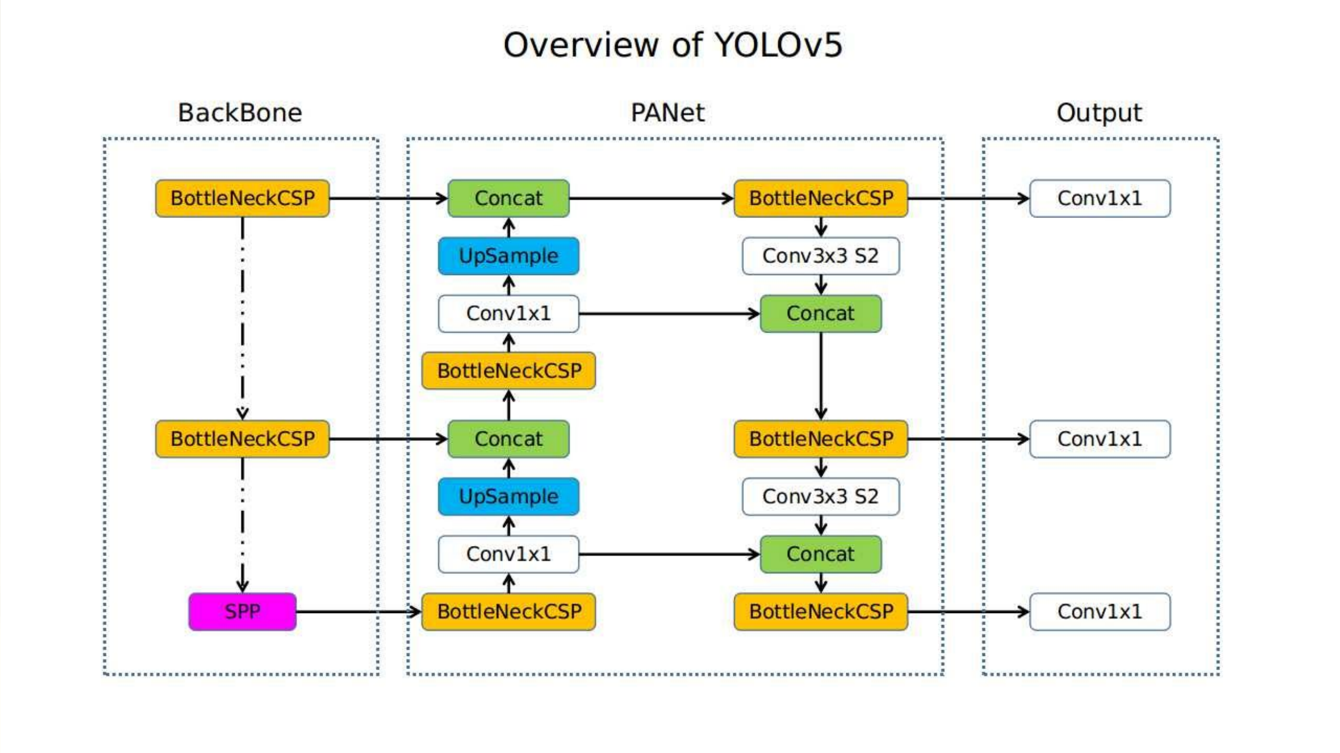

NICT


x 29
x 14642
Smoke
Non-Smoke
50%
50%
x 4000

Dataset Example

03 IMPLEMENTATION

YOLOv5


Overview of YOLOv5
BackBone
PANet
Output
BottleNeckCSP
BottleNeckCSP
SPP
Concat
UpSample
Conv1x1
BottleNeckCSP
Concat
UpSample
Conv1x1
BottleNeckCSP
BottleNeckCSP
Conv3x3 S2
Concat
BottleNeckCSP
Conv3x3 S2
Concat
BottleNeckCSP
Conv1x1
Conv1x1
Conv1x1

04 EVALUATION

The evaluation metrics

$$\text{Precision} = \frac{TP}{TP + FP}$$

$$\text{Recall} = \frac{TP}{TP + FN}$$

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

TP = number of true positives

FP = number of false positives

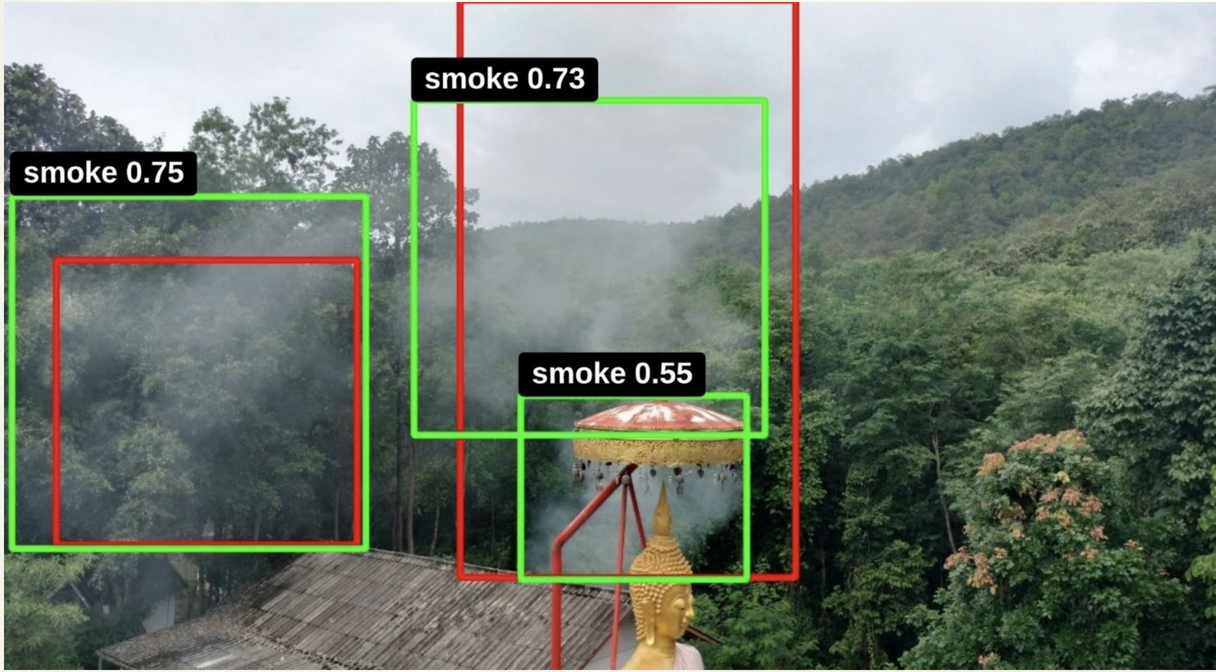
FN = number of false negatives

metrics of 4-fold cross-validation

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

Custom Evaluation

- image with smoke is counted as a TP if the model detects at least one smoke area with an IoU value larger than a predefined threshold; otherwise, it is considered a FN.
- image without smoke is counted as a TN if the model detects no smoke objects; otherwise, it is considered a FP.



Performance evaluation of our YOLOv5-based smoke detection.

IoU Threshold	Accuracy	Precision	Recall	F1-score	Balanced Accuracy
0.3	**0.9388**	**0.9740**	**0.9375**	**0.9554**	**0.9396**
0.4	0.9375	0.9740	0.9357	0.9545	0.9387
0.5	0.9375	0.9740	0.9357	0.9545	0.9387
0.6	0.9363	0.9739	0.9339	0.9535	0.9378
0.7	0.9338	0.9738	0.9304	0.9516	0.9360

Conclusion

Our Objective

- Develop dataset for early stage wildfire
- Showcase model to detect wildfire in their early stage

Dataset

x 29 Fire spots in Chiang Mai

x 4000

Smoke 50% | Non-Smoke 50%

Results

Prediction using YOLOv5 return accuracy of 93.88%

Future Enhancement

- expand the FireSpot database with multispectral images reveal a recognition of current limitations and a commitment to improving performance, especially during nighttime conditions.

Q and A

Checkout our Dataset here