Change Detection in Multi-temporal Remote Sensing Images for Landslide Monitoring

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Background

Ban Nam Ko, Phetchabun, Thailand (Aug 11, 2001)
136 casualties, 109 injures, 4 missing, 188 destroyed houses, and 645 million Baht of total damage

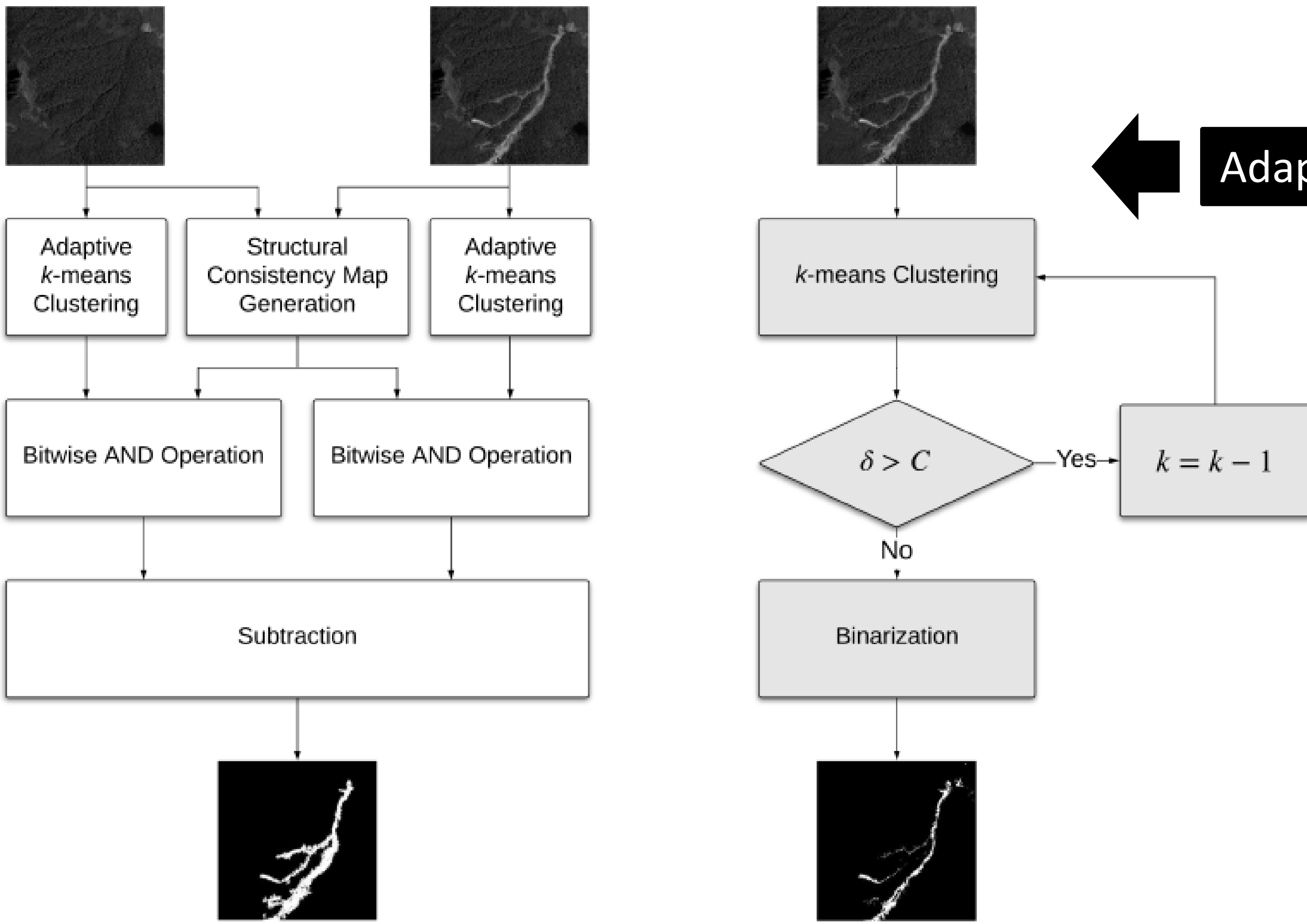
Purpose

To analyze multi-temporal remote sensing images (e.g., satellite imagery, LiDAR point cloud) by signal analysis techniques in order to detect changes due to landslides and to identify landslide-prone areas.

Objectives

- To develop unsupervised change detection in satellite images for landslide monitoring.
- To apply deep neural networks in landslide detection problems.
- To develop surface displacement detection techniques that are practical for real-time applications.

Unsupervised Change Detection in Multi-temporal Satellite Images



Adaptive k-means

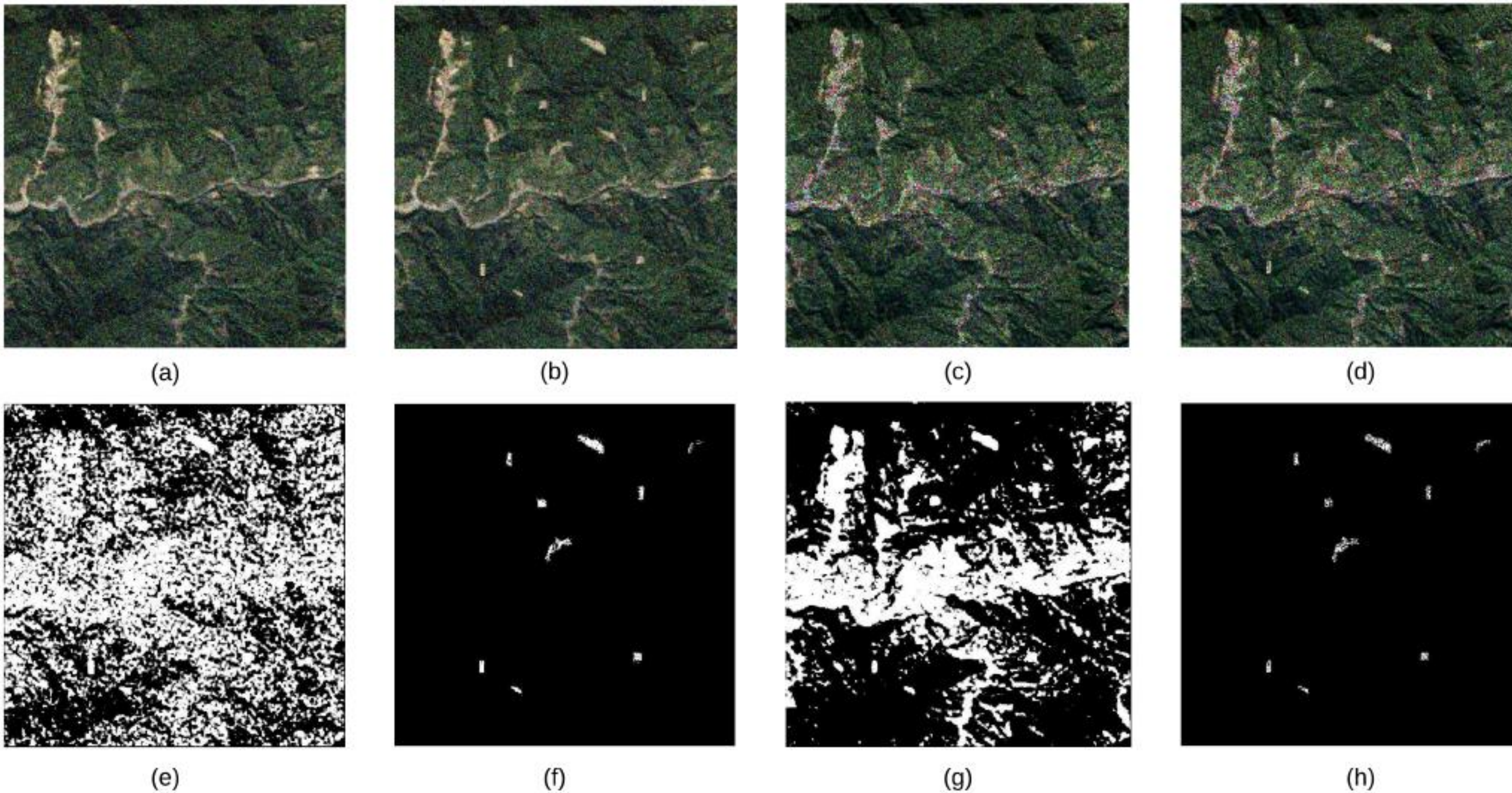
(a) (b)

Example of the dataset: (a) before-landslide events and (b) after-landslide events. The change maps obtained from the PCA-based method (c) and from the proposed method (d). (e) is the ground truth.

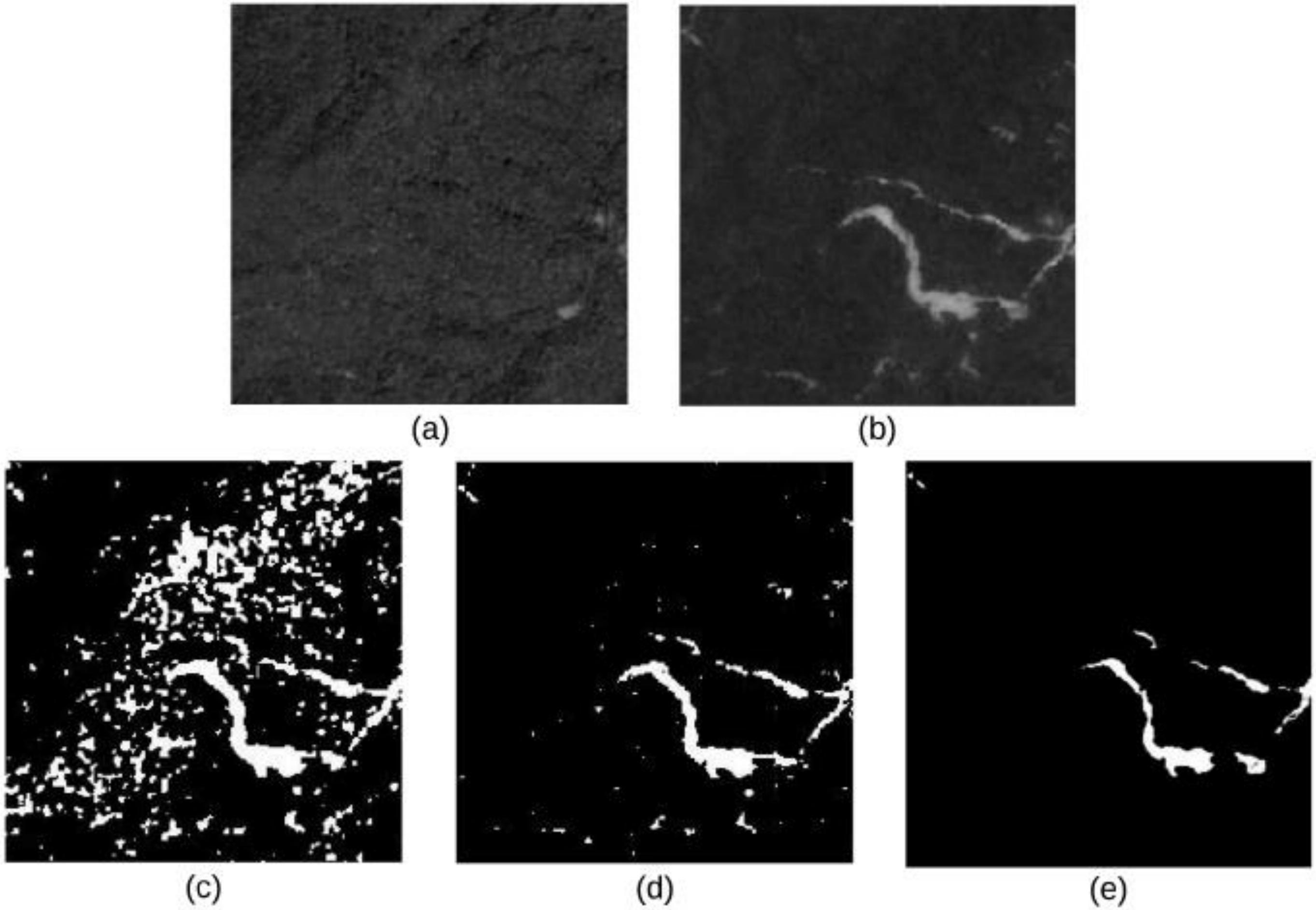
(c) (d) (e)

PCA-based VS Proposed

- 1.84 times faster
- More robust against noise
- Lesser false positives



Noise addition: (a) and (b) are the input images with the Gaussian noise (5 dB SNR); (c) and (d) are the input images with the speckle noise (5 dB SNR); (e) and (g) are the change maps from the PCA-based method; and (f) and (h) are the change maps from the proposed method.

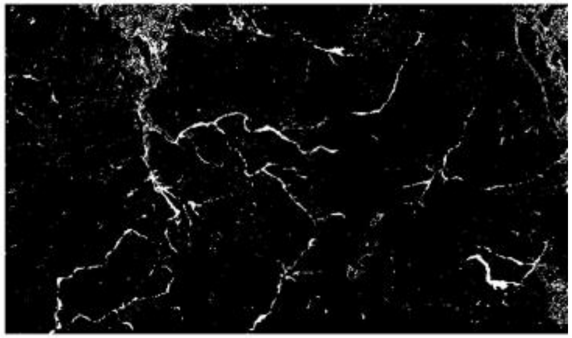


False positive detection of the PCA-based method: (a) and (b) are the input images, (c) is the change map of the PCA-based method. (d) is the proposed method's change map. (e) is the ground truth.

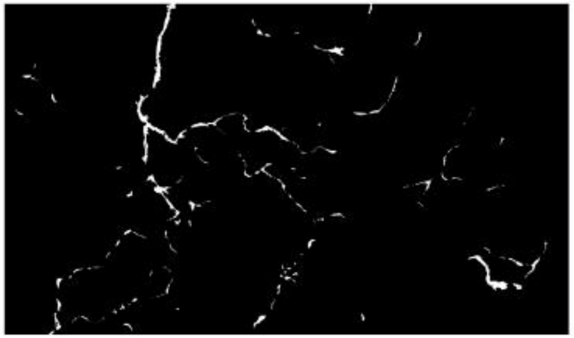
(a)

(b)

(c)



(d)



(e)

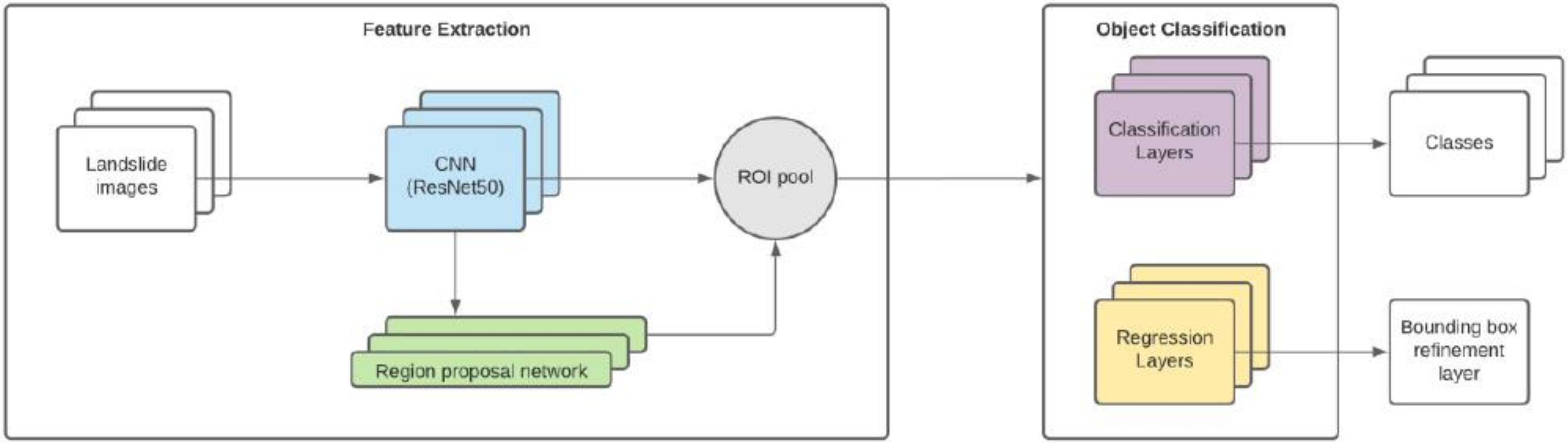
Dataset: (a) and (b) are input images, (c) is the change map of the PCA-based method. (d) is the proposed method's change map. Note that the PCA-based method could not detect change properly. (e) is the ground truth.

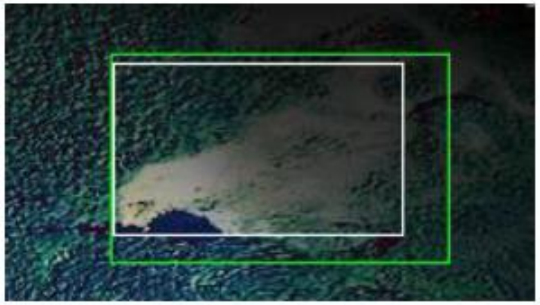
Unsupervised Change Detection in Multi-temporal Satellite Images

Research Gap & Challenges

- Even though the correctness of the proposed method is better than that of the conventional ones, the completeness is somehow poorer. One way to improve the completeness is by enhancing the accuracy of the segmentation algorithm. Thus, we will investigate that part in the course of this proposed project.
- So far, one of the most difficulties in landslide change detection is recognizing clouds and differentiating them from landslide scars. Thus, cloud detection is also proposed to integrate with the main framework.

Landslide Detection Based on R-CNN





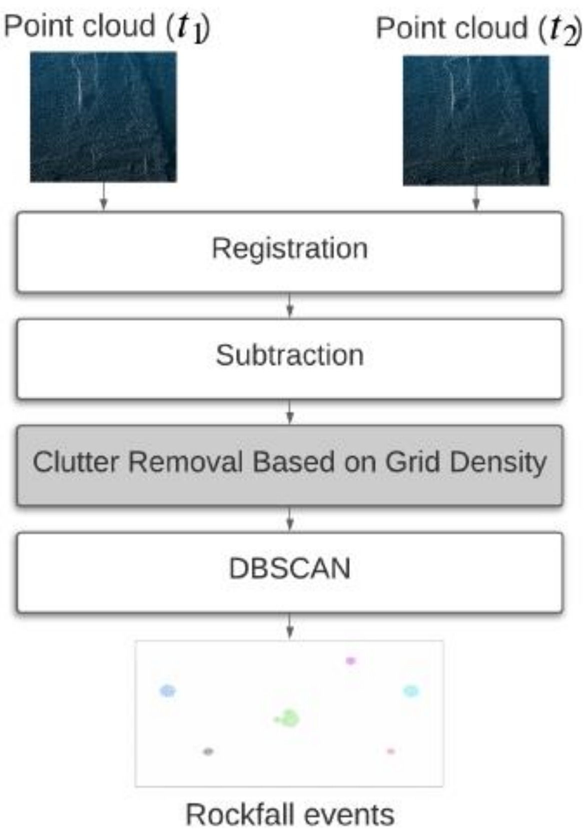
R-CNN architecture used in our experiments (top), preliminary results (bottom-left: input image, bottom-middle: predicted location (green) and ground truth (white)), and a DEM image (bottom-right).

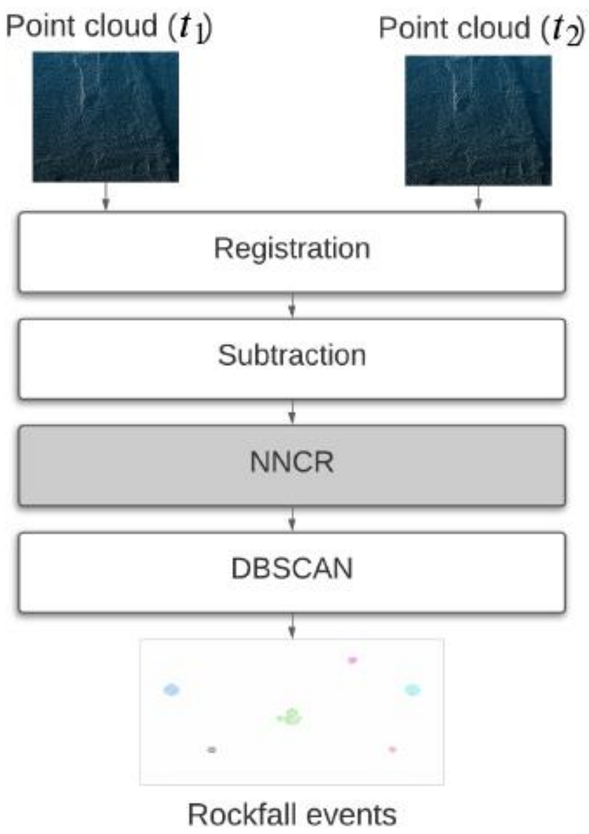
Landslide Detection Based on R-CNN

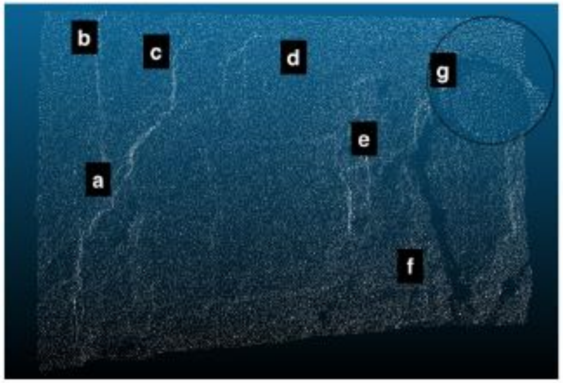
Research Gap & Challenges

- A research gap to be filled during the proposed project is the overall accuracy improvement by applying the following proposed concept. Another R-CNN that takes the digital elevation model (DEM) of the same area is to be constructed. Then, the predicted locations from both models are combined by using data fusion techniques.

Surface Displacement Detection from Terrestrial LiDAR Point Clouds







Surface Displacement Detection from Terrestrial LiDAR Point Clouds

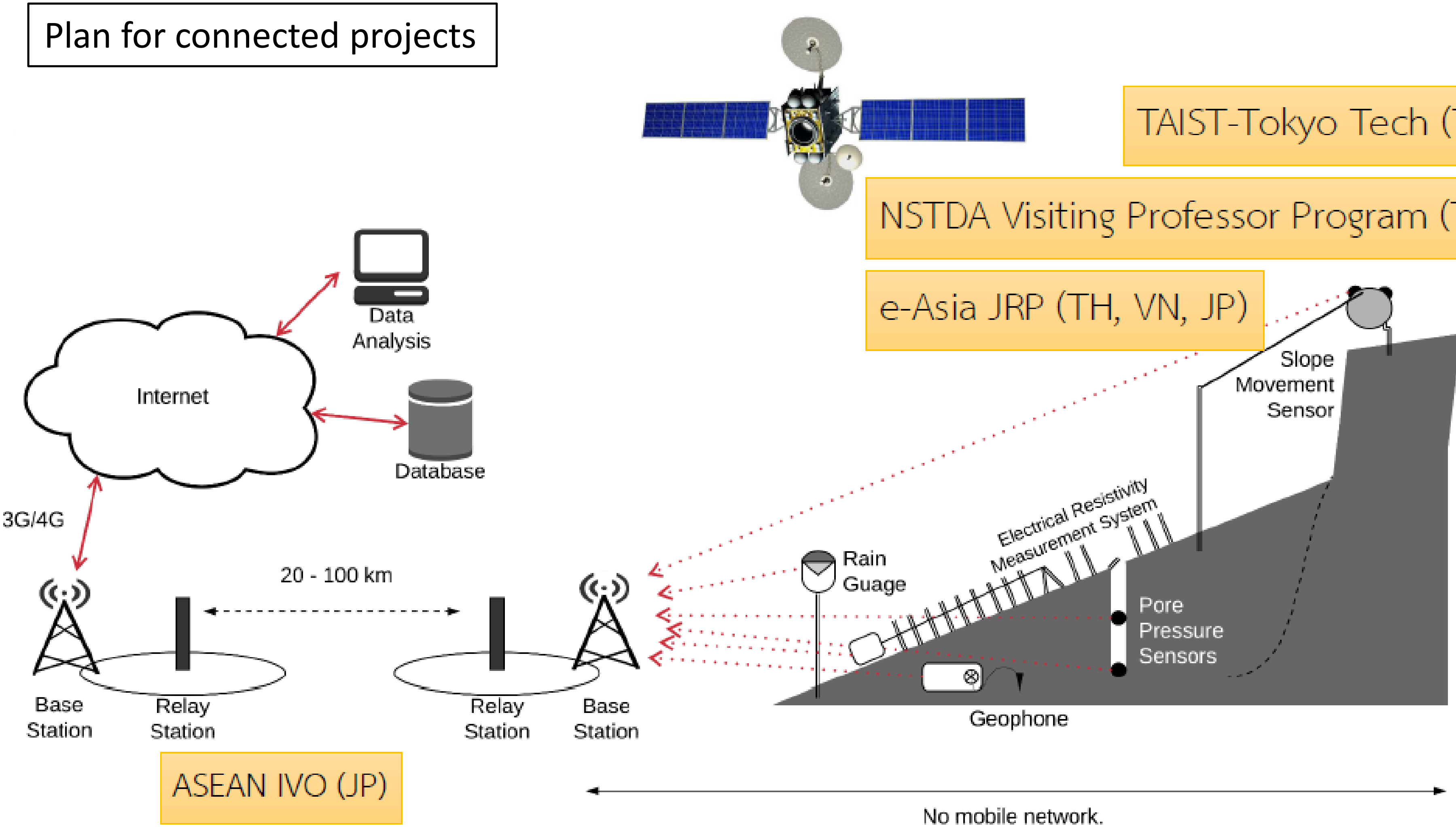
Research Gap & Challenges

- Automatic parameter estimation for DBSCAN
- Accuracy improvement
- Optimization (e.g., computational cost)

Plan for connected projects

Project	Period	Partner	Funding Source	Relation/Integration
Real-time Monitoring Based on Wireless Sensor Networks for Landslide-prone Areas	2018-2021	PHL, LAO	ASEAN COSTI	The proposed project has some overlapped areas with these two projects in the monitoring part. The approaches used are different. The former is remotely-based, whereas the latter is locally-based, such as the Visual IoT and wireless sensor networks.
Establishment of a Landslide Monitoring and Prediction System	2019-2021	JPN, VNM	e-Asia JRP	
Relay Station Network Based on Low-power Wide-area Network (LPWAN) Technologies	2019-2021	JPN, BRN, PHL, LAO, MMR	ASEAN IVO	Landslide-prone areas can be identified by the proposed project. The relay networks can collect the local parameters in those areas. Both can work together.

Plan for connected projects



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NSTDA Visiting Professor Program (TH)

e-Asia JRP (TH, VN, JP)

ASEAN IVO (JP)

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