Visual IoT Techniques for Resilient Natural Disaster Mitigation

Ken T. Murata

National Institute of Information and Communications Technology (NICT), Japan

Research Executive Director at National Institute of Information and Communications Technology. Currently engaged in spatio-temporal data GIS platform project and resilient natural environment measurement project.

HAIYAN (Typhoon #30) in 2013 (Philippines)

画像2　2013年、猛烈（もうれつ）な台風30号「ハイヤン」がフィリピンを直撃。深刻な被害をもたらした。　ロイター/アフロ

HAIYAN (Typhoon #30) in 2013 (Taiwan)

“Floods cause chaos and deaths” in southern Thailand in 2017

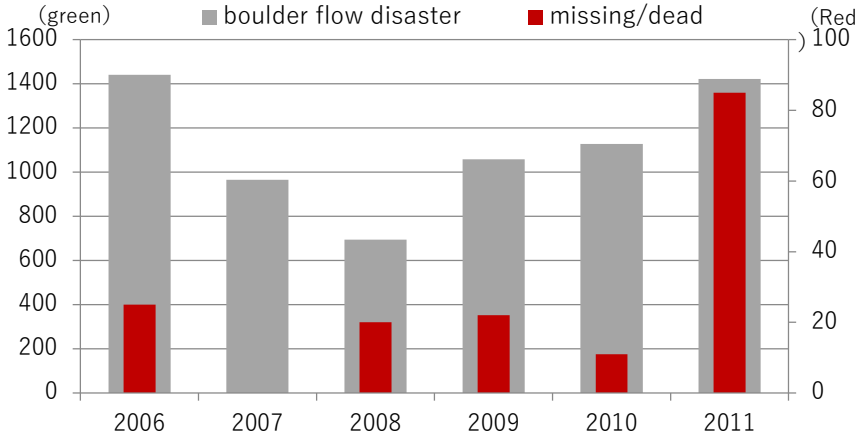
Houses submerged by floodwaters in Nakhon Si Thammarat province, southern Thailand

Landslide case in Aug. 2021, Atami, Japan

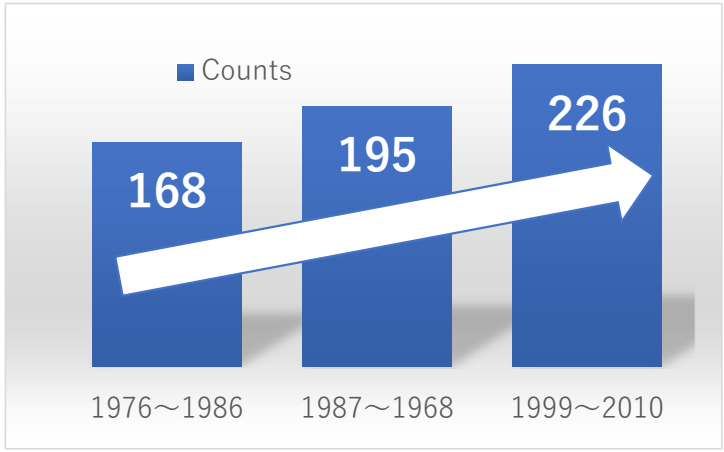
https://www3.nhk.or.jp/news/html/20210703/k10013117711000.html

Disasters caused by local heavy rainfall (precipitation) in Japan

Landslide disaster on 20 Aug. 2014 in Hiroshima (Japan). 72 people died.

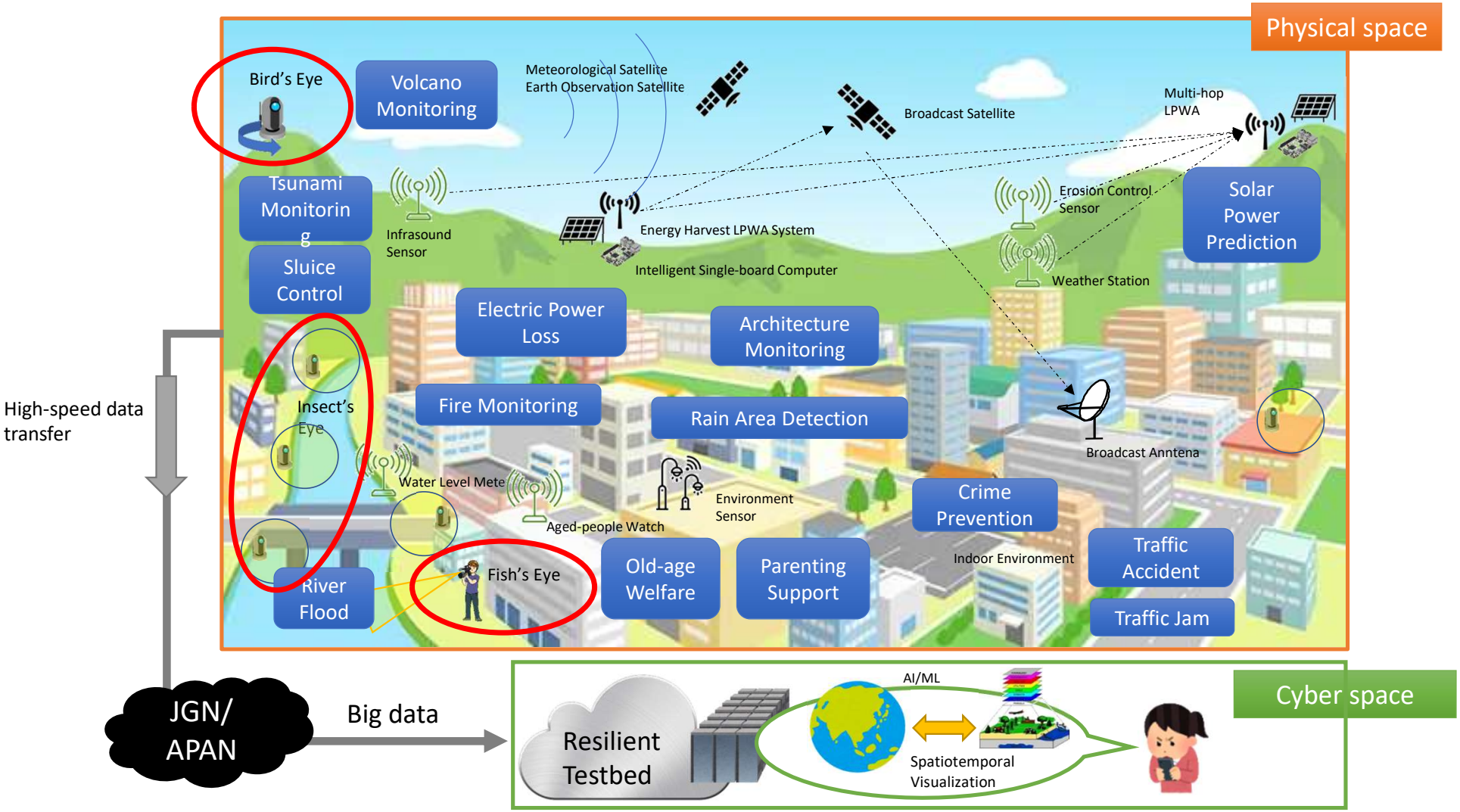


Landslide disaster and missing/dead between 2006 and 2011.

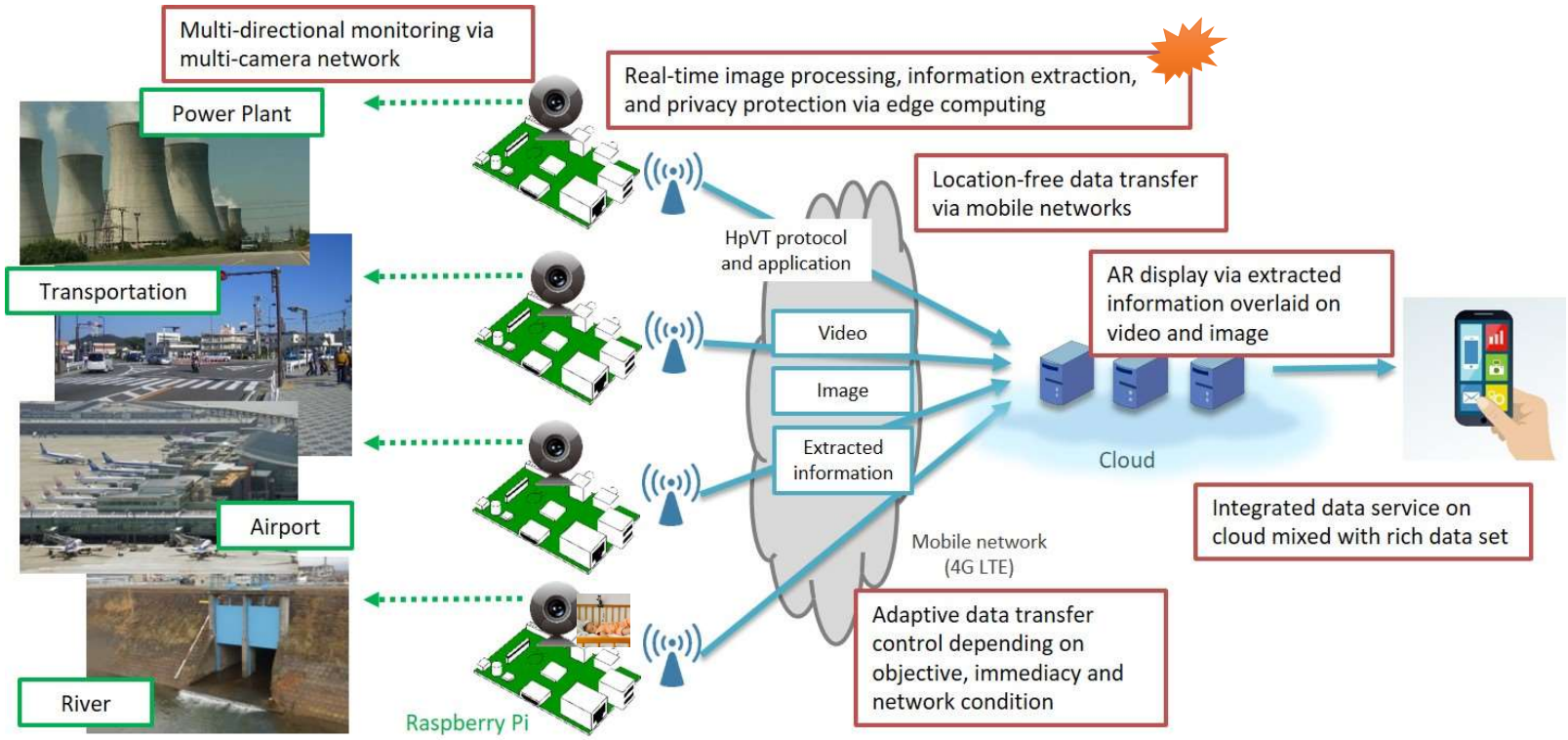


Occurrence of local heavy rain in each decade since 1976.

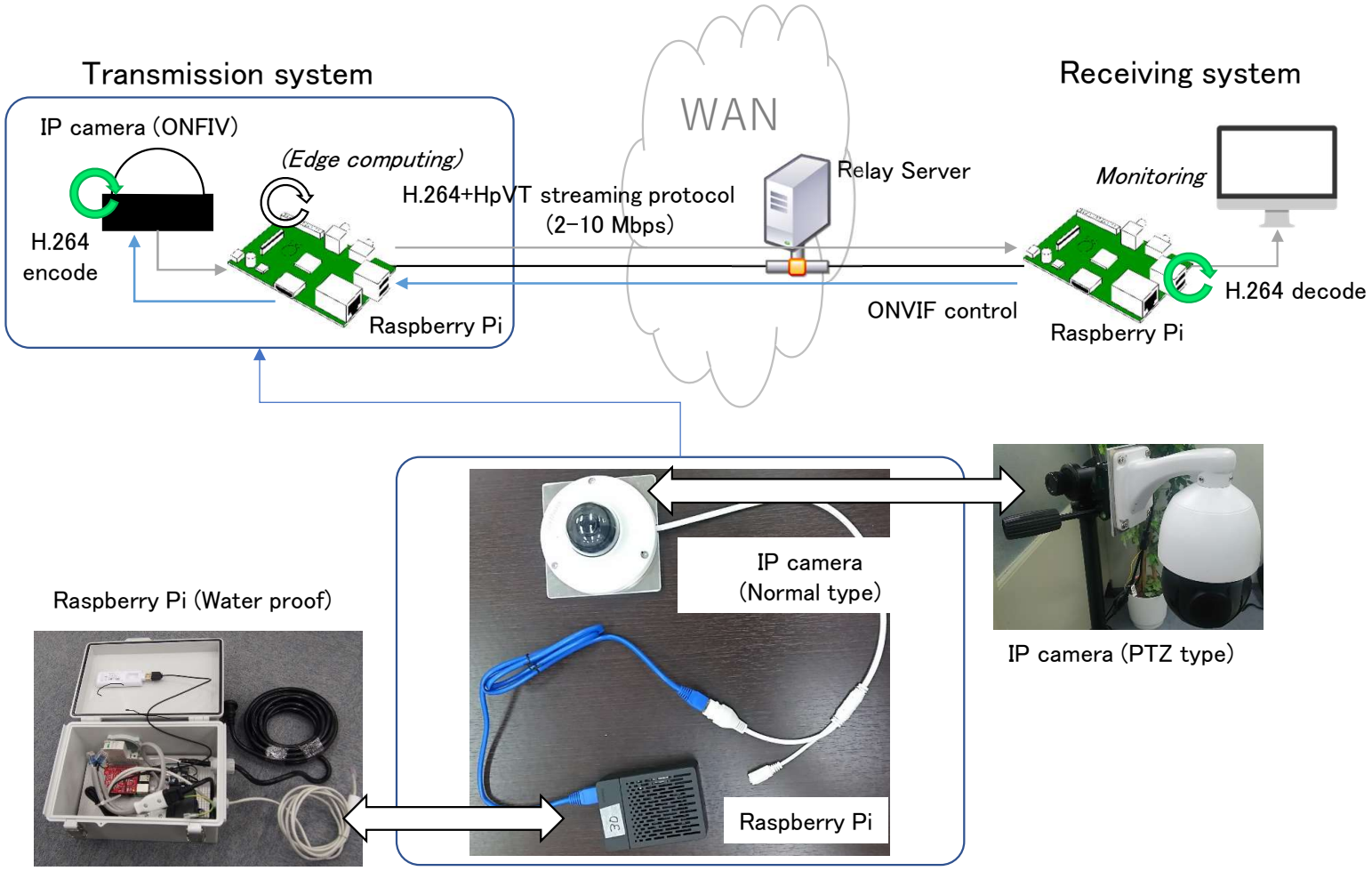
Resilient Natural Disaster Mitigation Concept: Cyber-Physical



Concept of “Visual IoT”

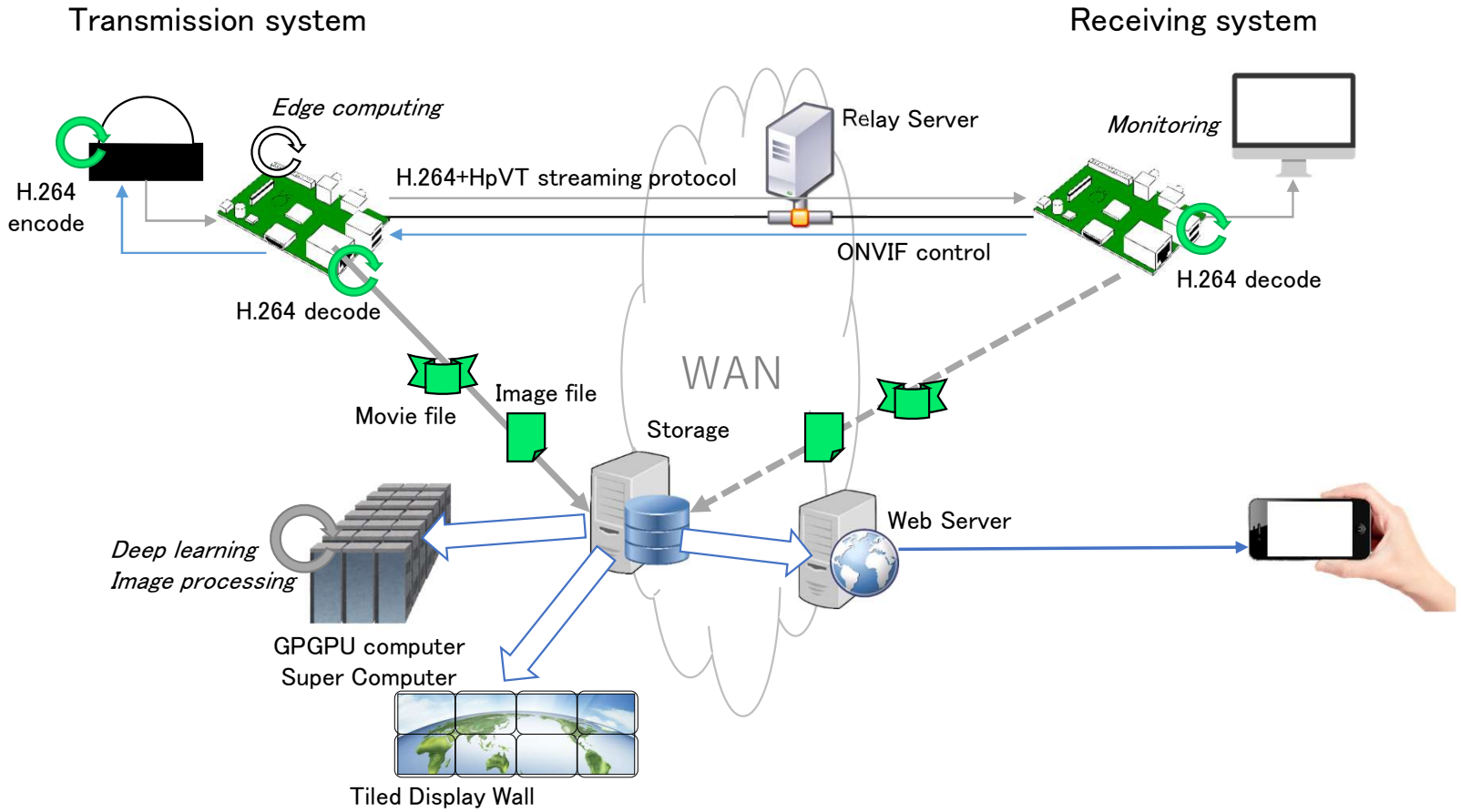


Visual IoT System Configuration



Visual IoT Implementation

expansion to AI and large-scale visualization



Commercial IP camera

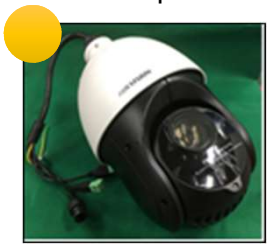
ONVIF (profile S) required

300 – 1,500 USD

Desk-top type

Barrett type

Japanese lantern type



Dome type

PTZ (Pan-Tilt-Zoom)

System

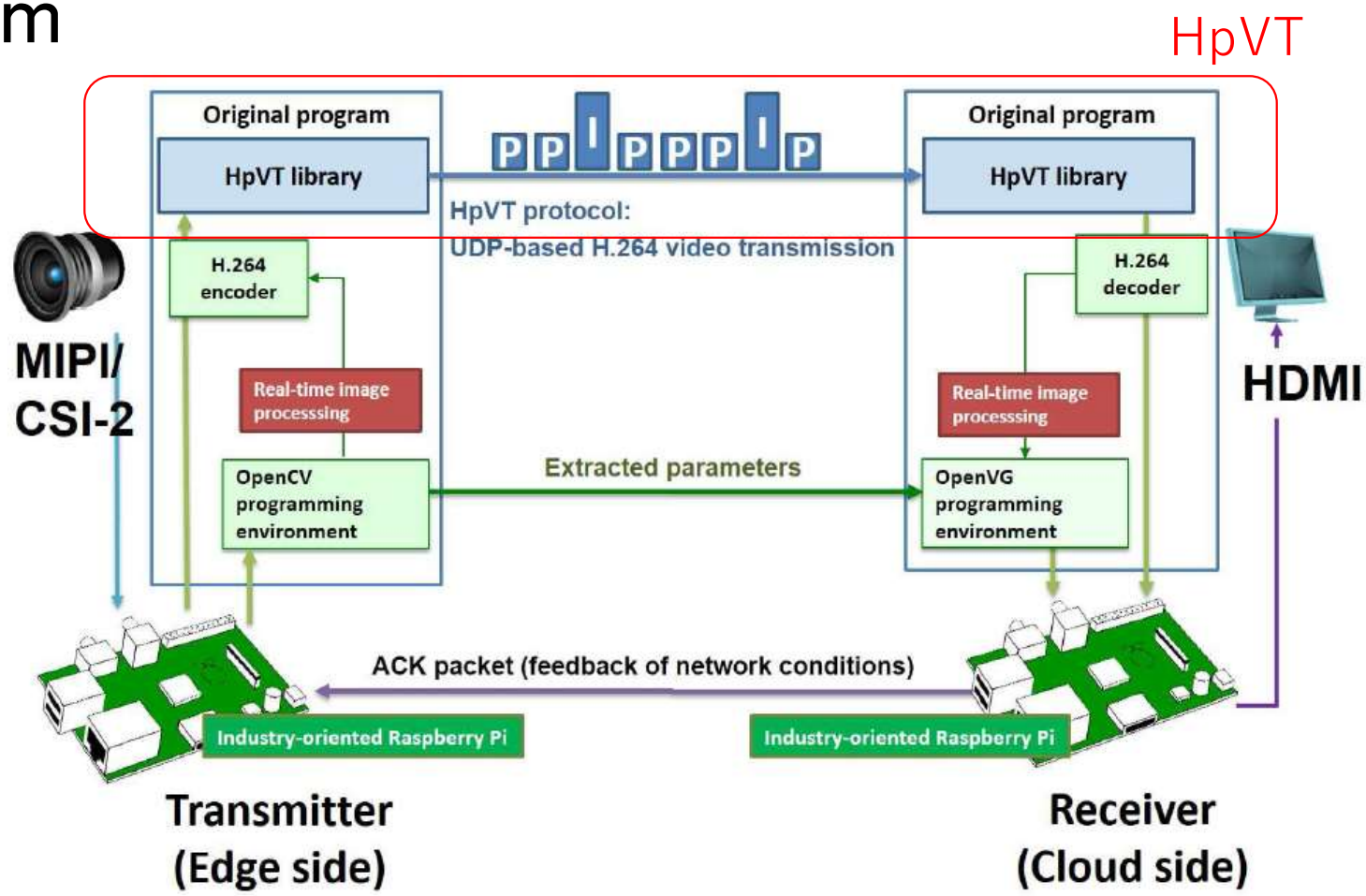


Fig. 1: A schematic picture of the HpVT protocol and HpVT application.

Overview of transmission and receiving video system

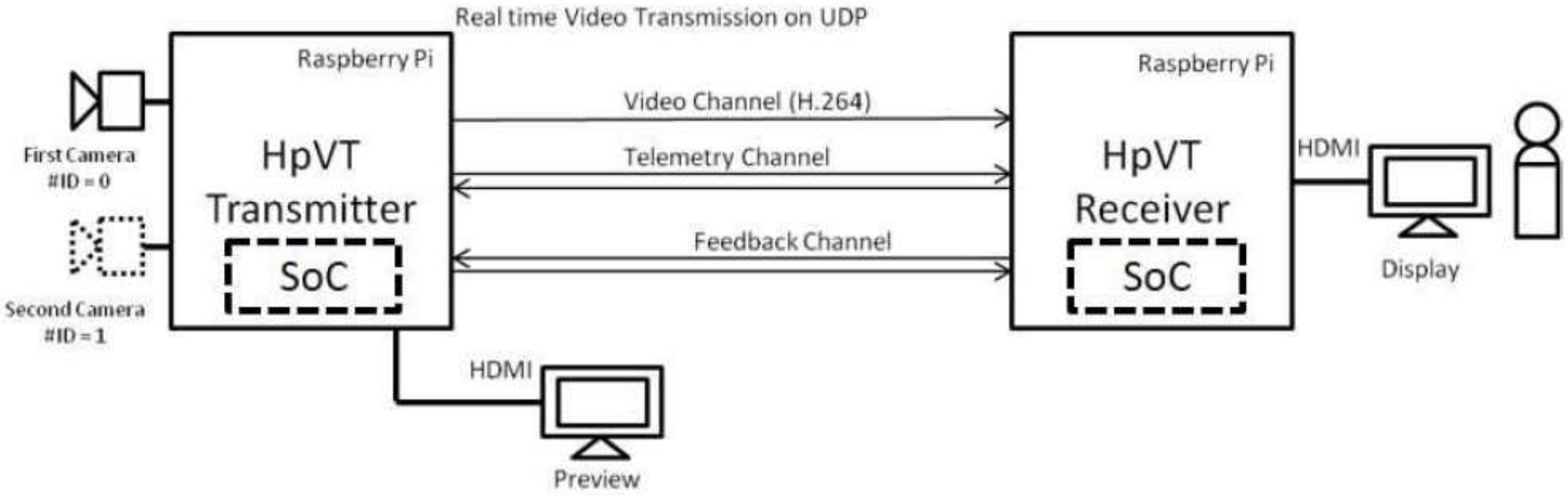


Fig. 2: Overview of transmitting and receiving video system.

Specification of a PTZ Camera

Hikvision: DS-2DE4425IW-DE

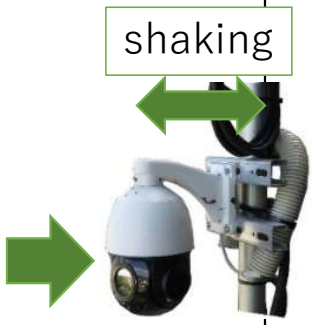
(about 200 US dollars)

Camera Specification

Provider	HIKVISION
Model	DS-2DE4425IW-DE
Min. / Max. angle (Pan)	$-180° / +180°$
Pan range (p)	Normalized as $-1 \leq p \leq 1$
Min. / Max. angle (Tilt)	$-15° / +90°$
Tilt range (t)	Normalized as $-1 \leq t \leq 1$
Min. / Max. zoom ratio	$\times 1 / \times 25$
Zoom range (z)	Normalized as $0 \leq z \leq 1$
Maximum resolution	2560×1440 pixels
Frame rate	25 fps or 50 fps
Focal length (at min. zoom level) Focal length (at max. zoom level)	1950 pixels 38025 pixels

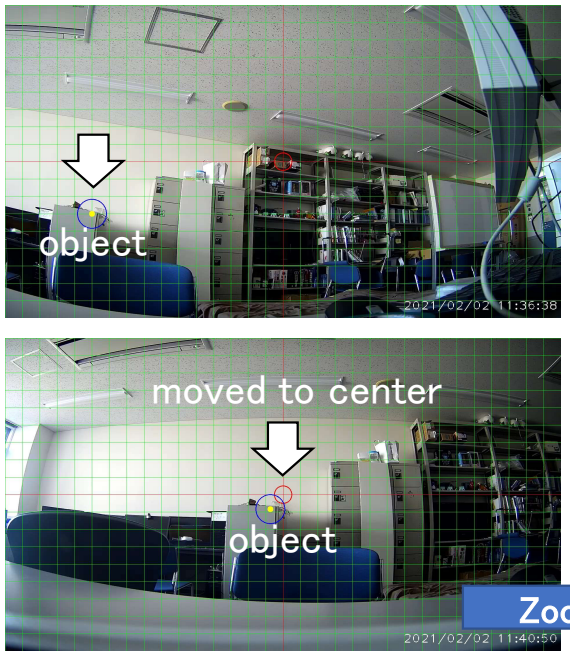
Customization of Visual IoT technique

Feature key point technology



"Camera shake" is not evitable in case of outdoor camera (bird's eye camera). Stabilization of movie footage is important to detect slight difference on daily images.

Remote Pan–Tilt–Zoom operation



Centering of object in an arbitrary position using remote PTZ operation technique. Centering is important since it enables zooming up the object.

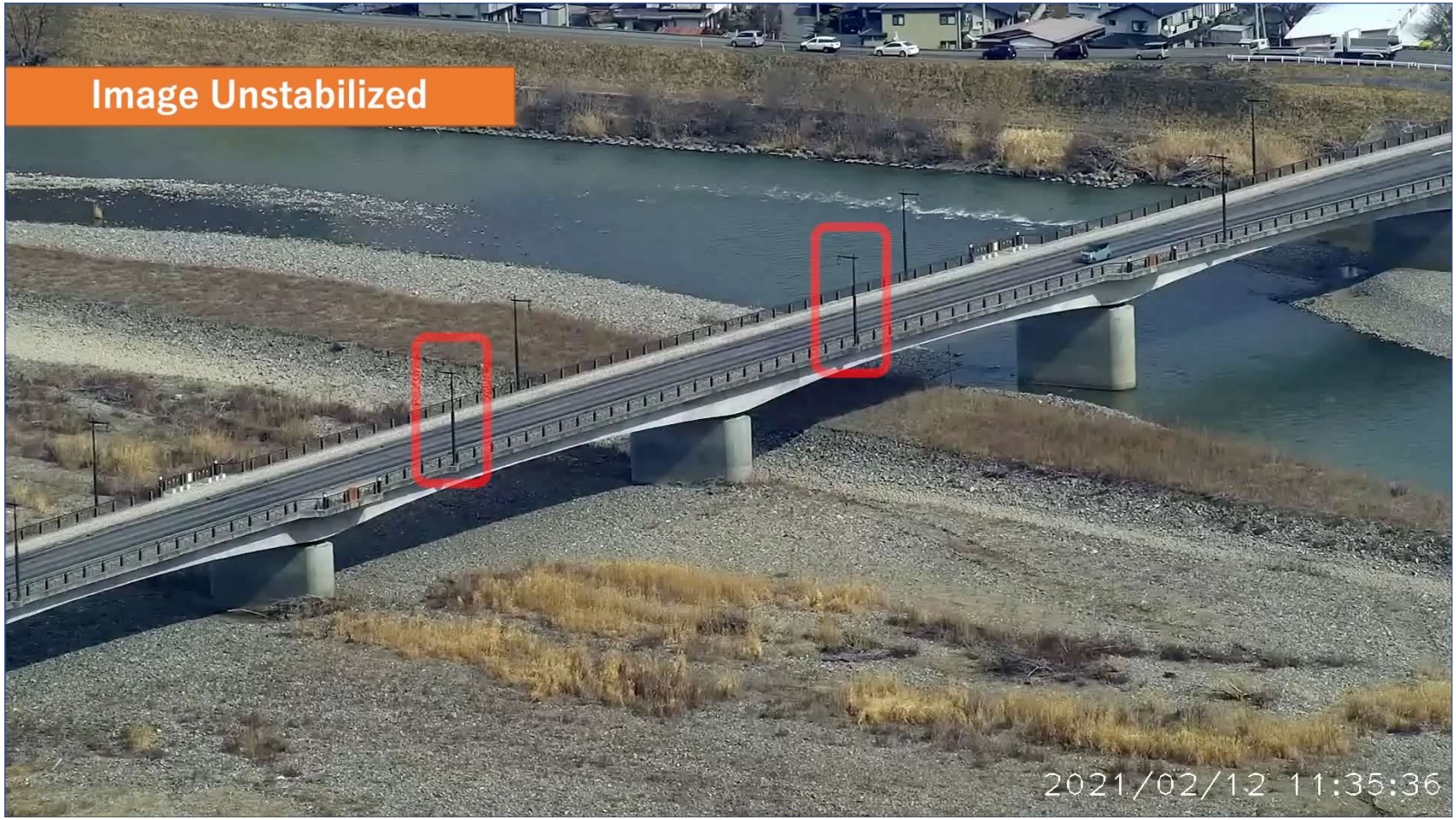
FINAL GOAL

Intelligent and autonomous robot eye to detect, locate, analyze landslides

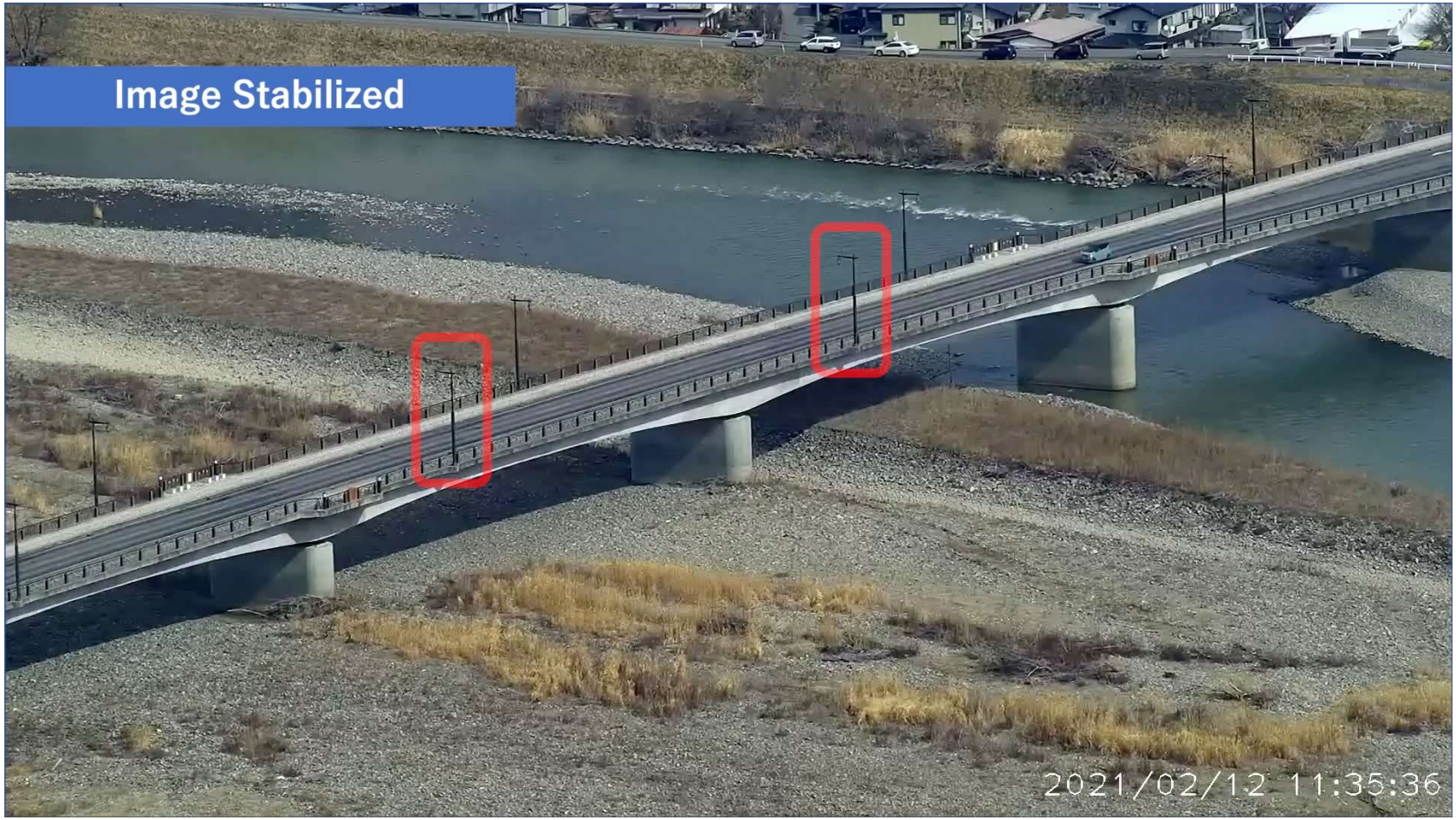
Results – Stabilized Examples of an Insect's eye – Normal movie

Results – Stabilized Examples of an Insect's eye – Normal movie

Results – Stabilized Examples of a Bird's eye – Time-lapse movie

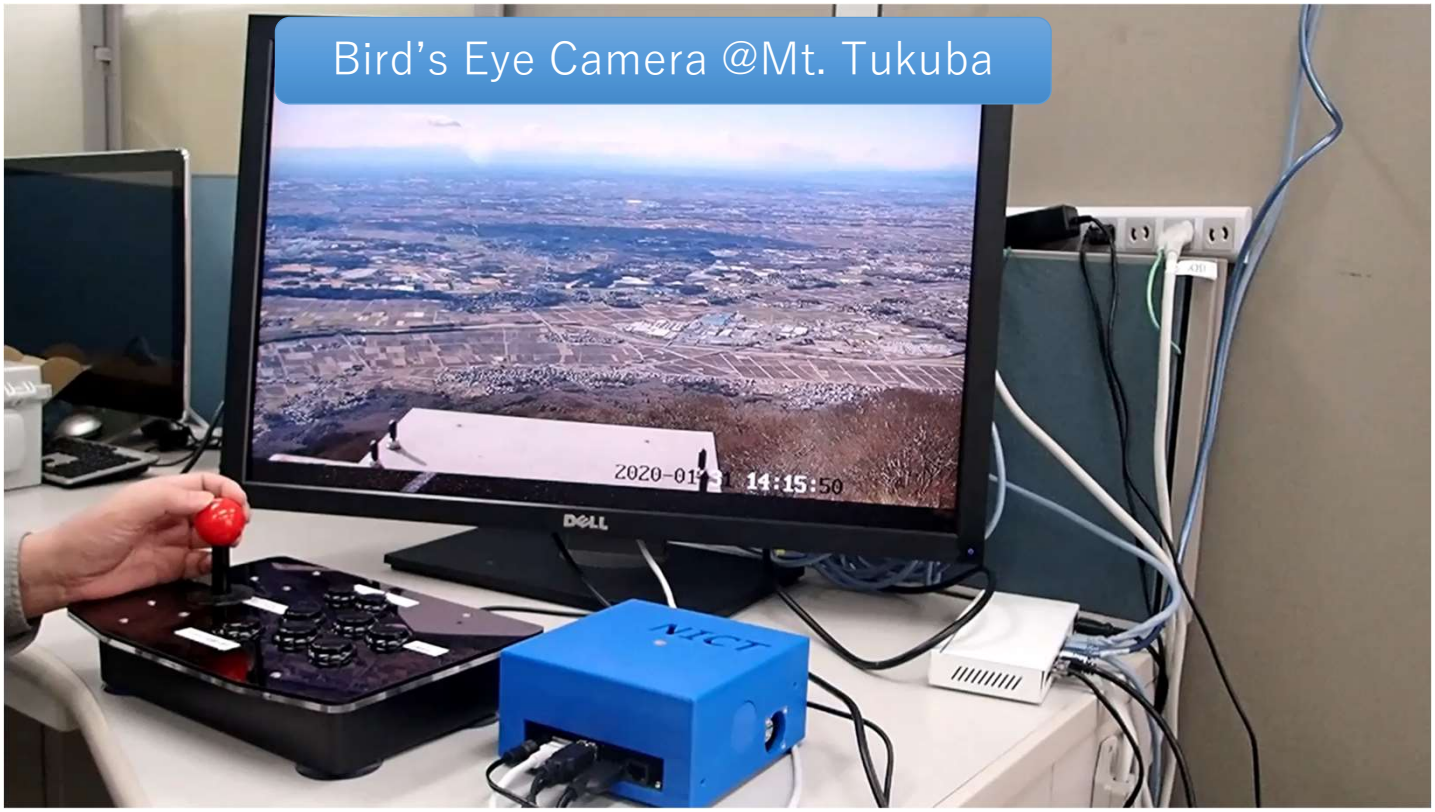


Results – Stabilized Examples of a Bird's eye – Time-lapse movie



Manual PTZ (Pan-Tilt-Zoom) operation

https://www.youtube.com/watch?v=cNCGVany0BQ&feature=youtu.be

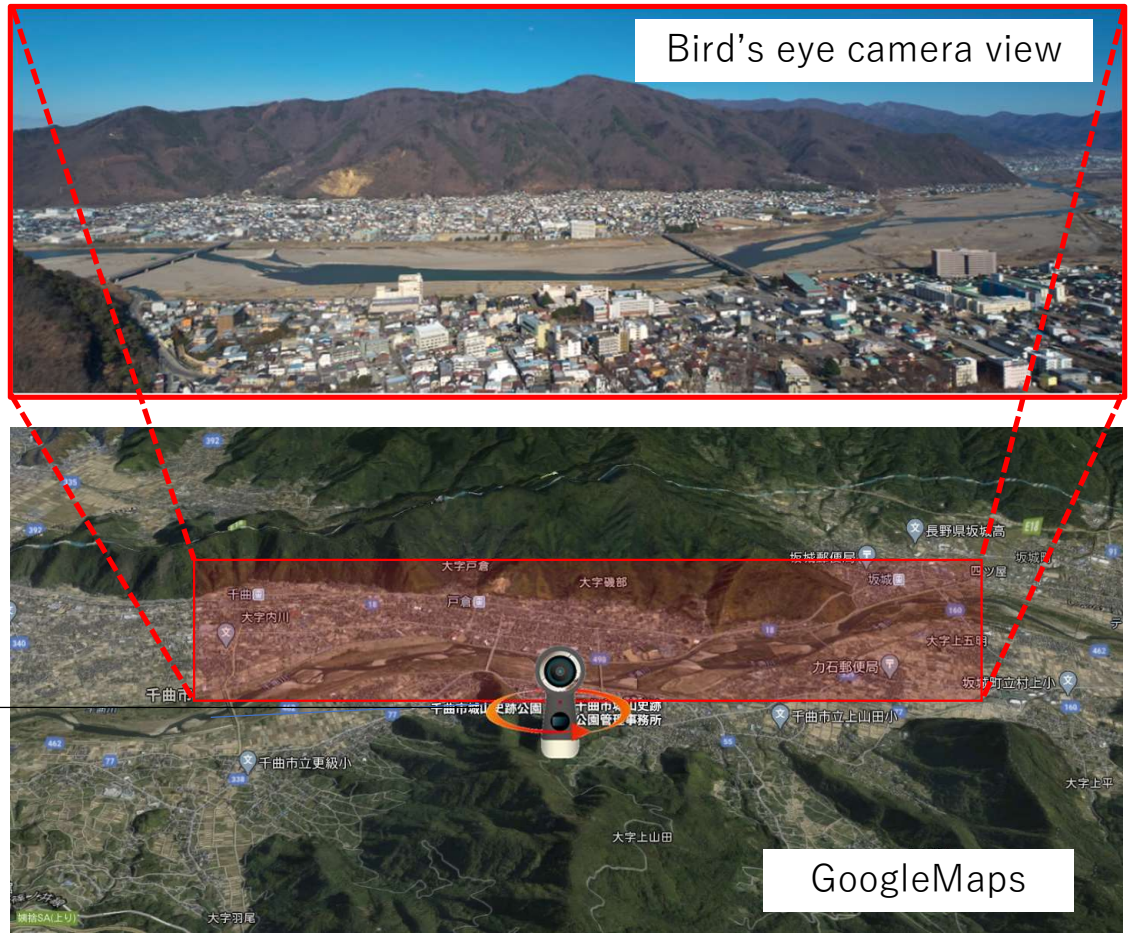


Highly precise PTZ (Pan-Tilt-Zoom) operation

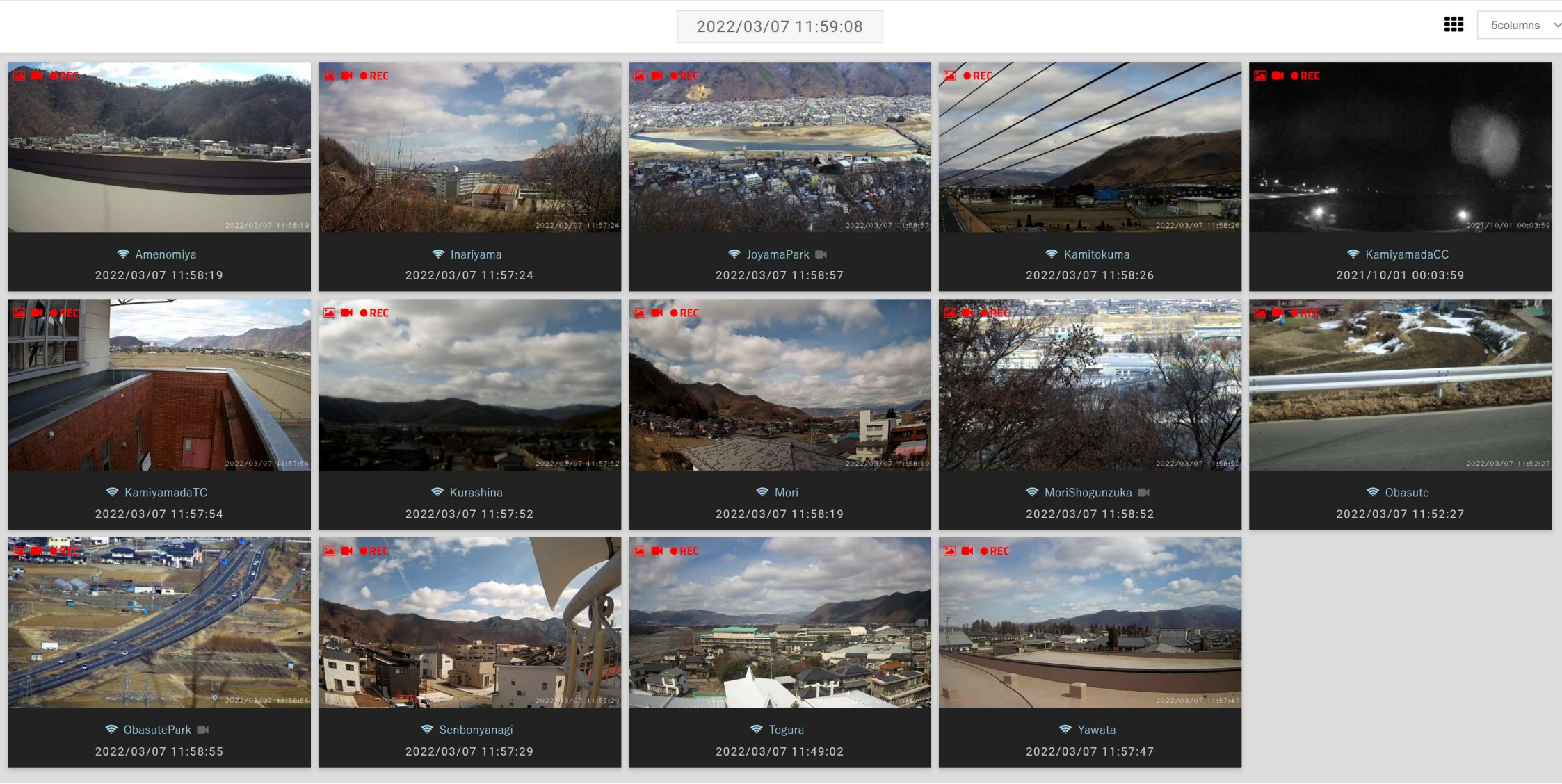
Chikuma ANZU project (Nagano prefecture, Japan)

Pan-Tile-Zoom function

Chukuma city, Nagano, Japan



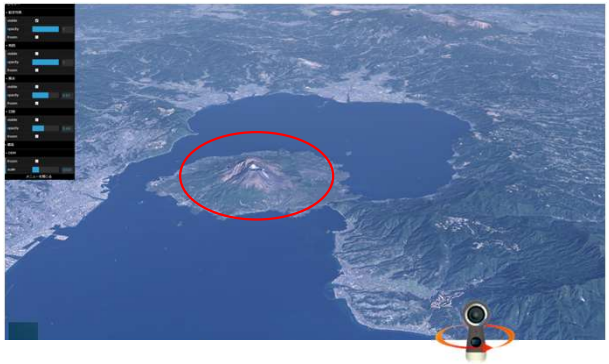
Chikuma ANZU project: Visual IoT system



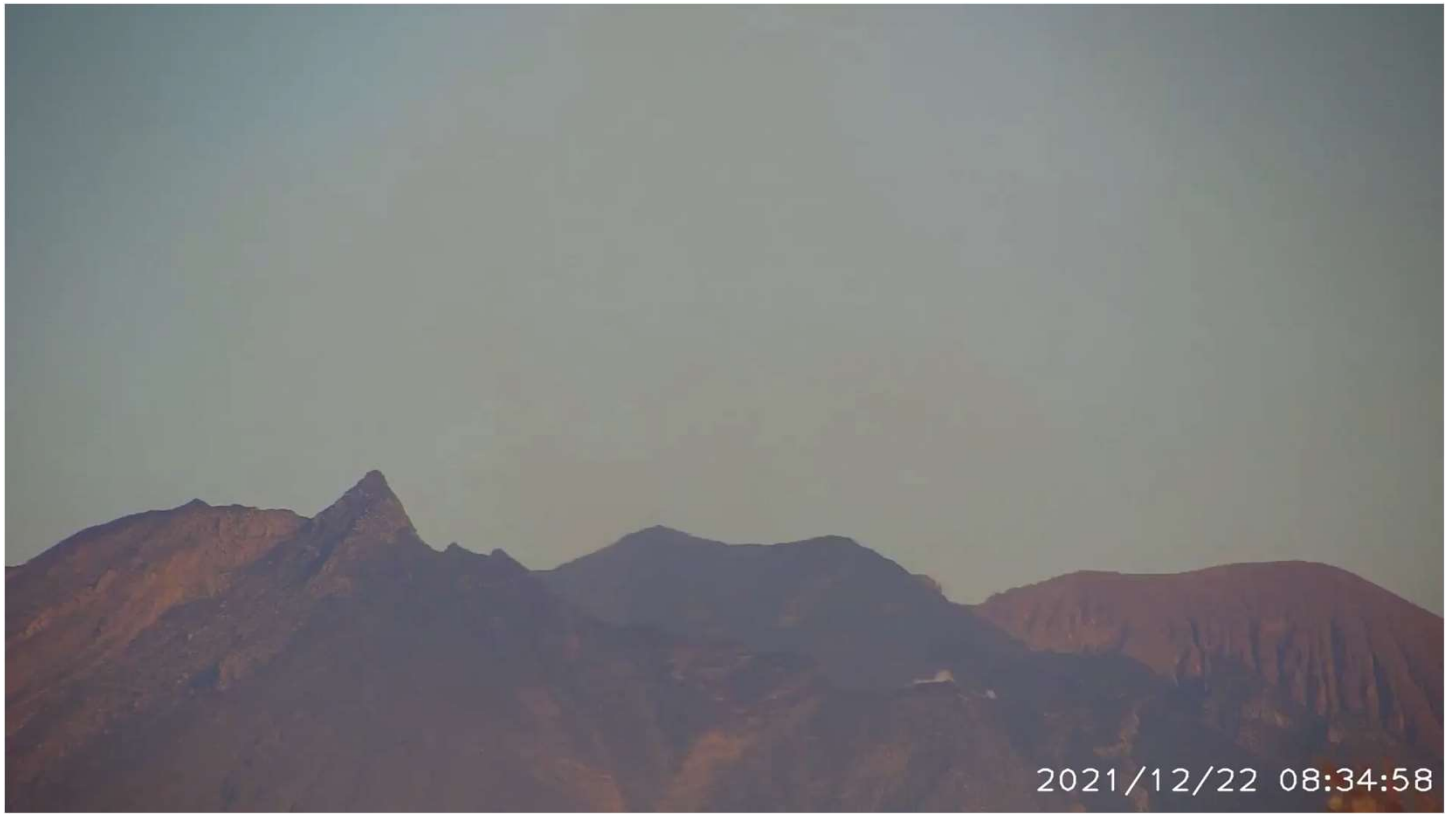
Insect’s Eye: Snowfall Detection (Daytime/Nighttime)

Amenomiya, Chikuma, Nagano (Japan)

Autonomous Smoke Detection



Volcano Monitoring (remote)
Sakurajima@Kagoshima Volcano Monitoring

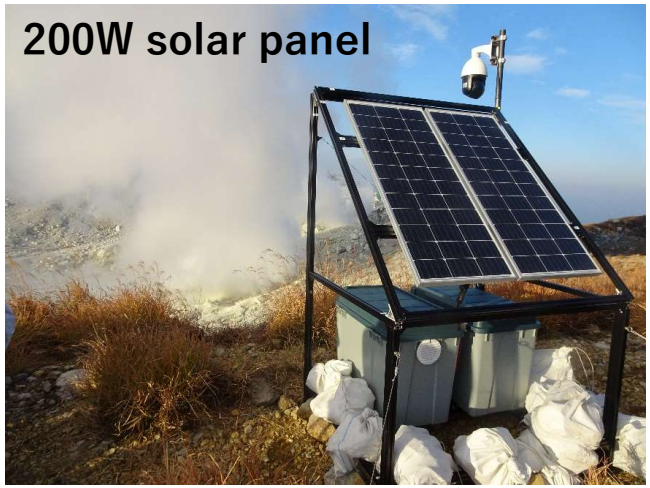


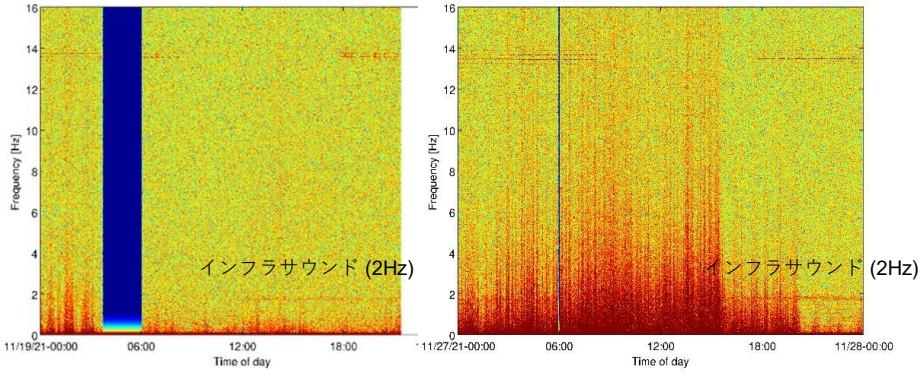
Date/Time	JMA (official)	Visual IoT
2021-12-20 12:56	×	○
2021-12-21 08:05	○	○
2021-12-22 08:38	○	○
2021-12-22 13:17	×	○
2021-12-22 17:37	×	○
2021-12-24 17-29	×	○
2021-12-28 23-24	○	×
2022-01-01 21-05	○	×
2022-01-02 11:39	×	○
2022-01-04 12:17	×	○
2022-01-05 08:48	×	○
2022-01-07 01:43	○	×
2022-01-18 03:24	○	×
2022-01-18 23:24	○	×

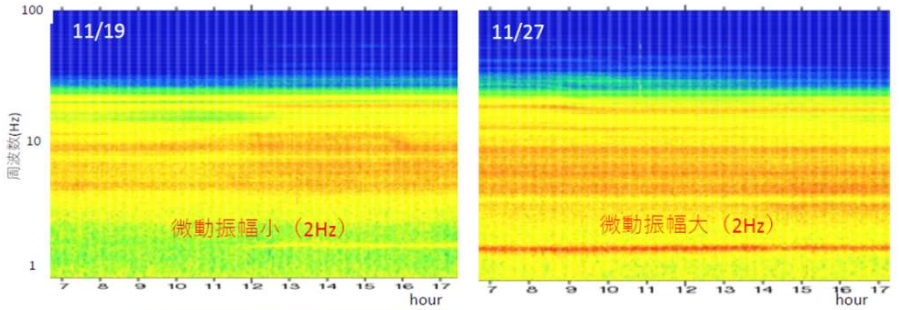
Daytime

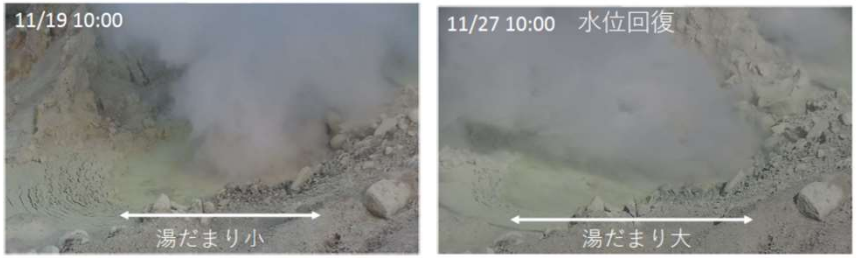
Nighttime

Volcano Monitoring (in situ): Ebino@Miyazaki, Japan









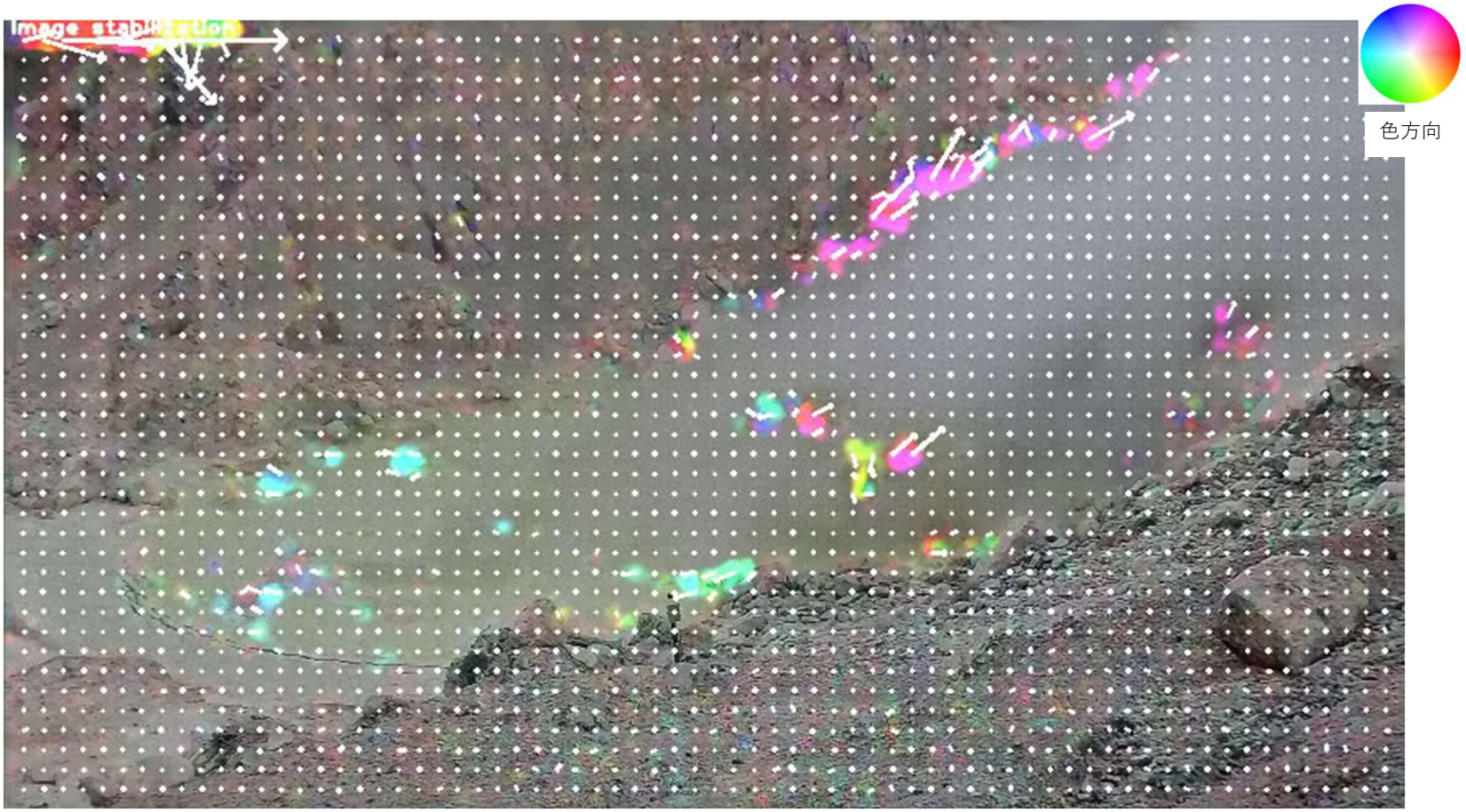
Iou-yama volcano @Miyazaki, Japan

Volcano Monitoring (in situ)

Realtime Movie

Volcano Monitoring (in situ)

Optical Flow Analysis and Visualization



Summary

- We introduce our efforts so far regarding “Resilient Natural Environment Measurement Project”.
  - A novel technique to monitor natural areas using new ICT (information and communications technologies)
- One of the concepts in the project is to monitor via “eye” (Visual IoT) and “ear” (infrasound) in association with “hands” (legacy IoT sensors).
- Visual IoT techniques
  - Real-time video and image transmission and AI-based processing play a significant role in disaster mitigations such as smoke detection, land-slide monitoring, snow fall watch and water level monitoring.