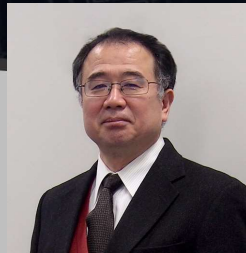


Visual IoT Techniques for Resilient Natural Disaster Mitigation

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

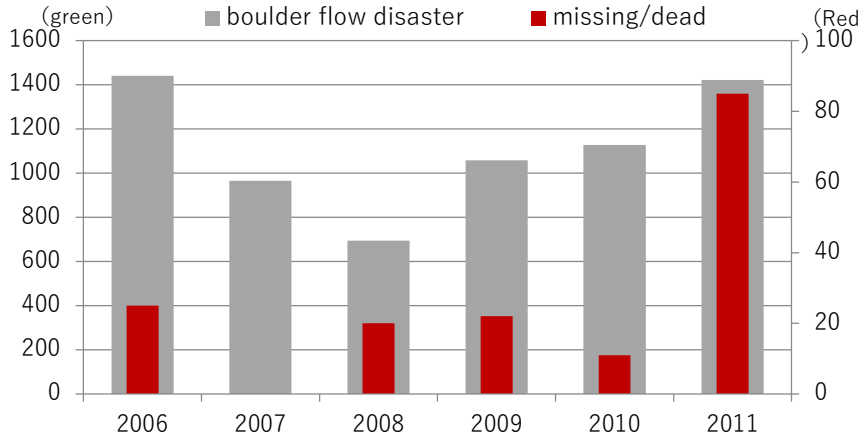


<https://www3.nhk.or.jp/news/html/20210703/k10013117711000.html>

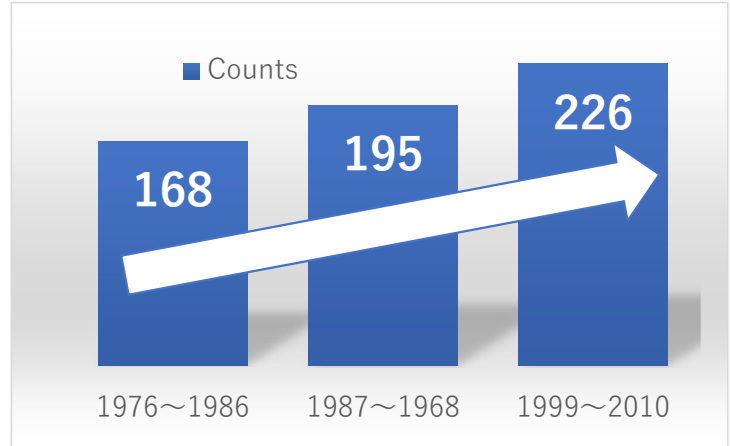
Disasters caused by local heavy rainfall (precipitation) in Japan



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

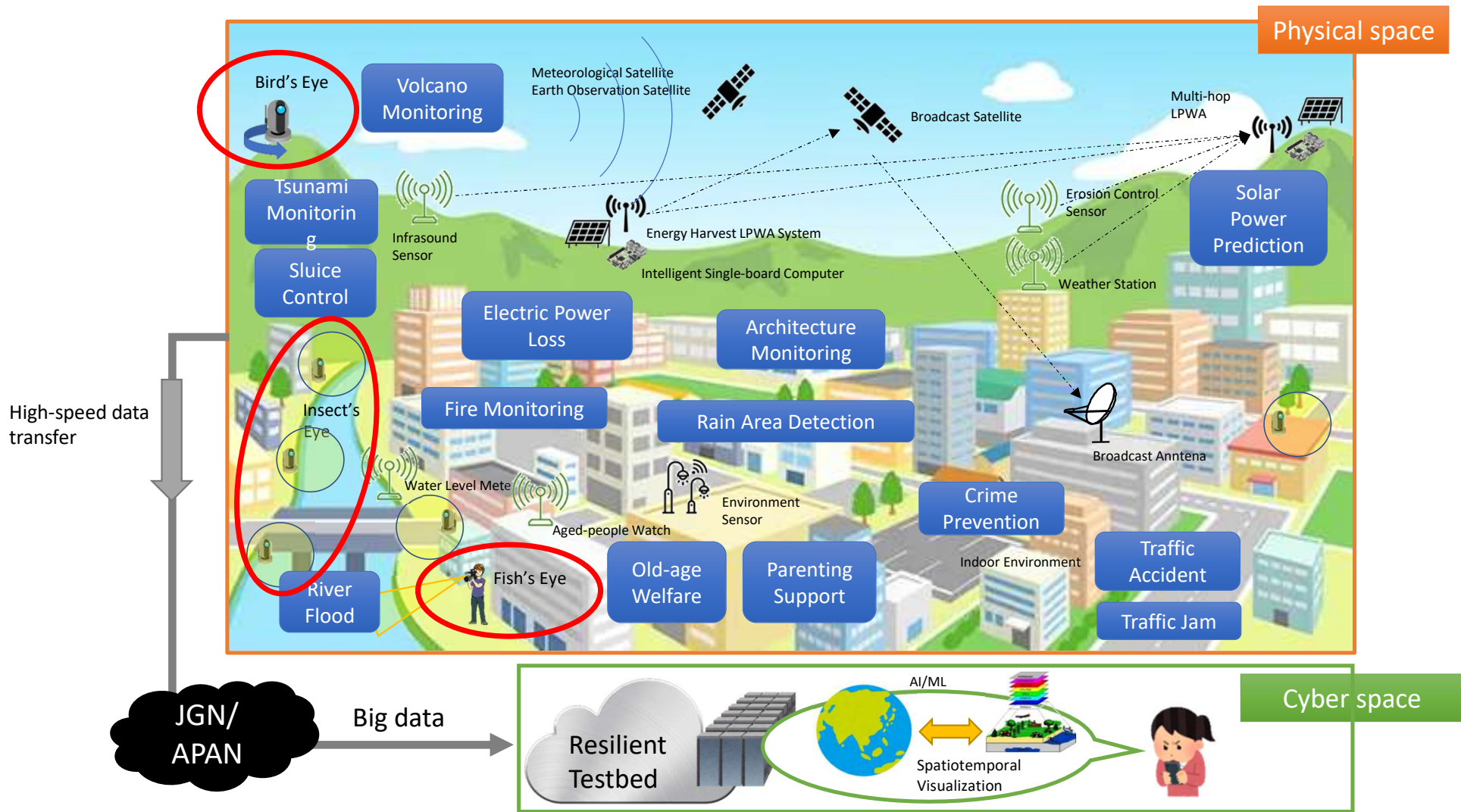


Landslide disaster and missing/dead between 2006 and 2011.

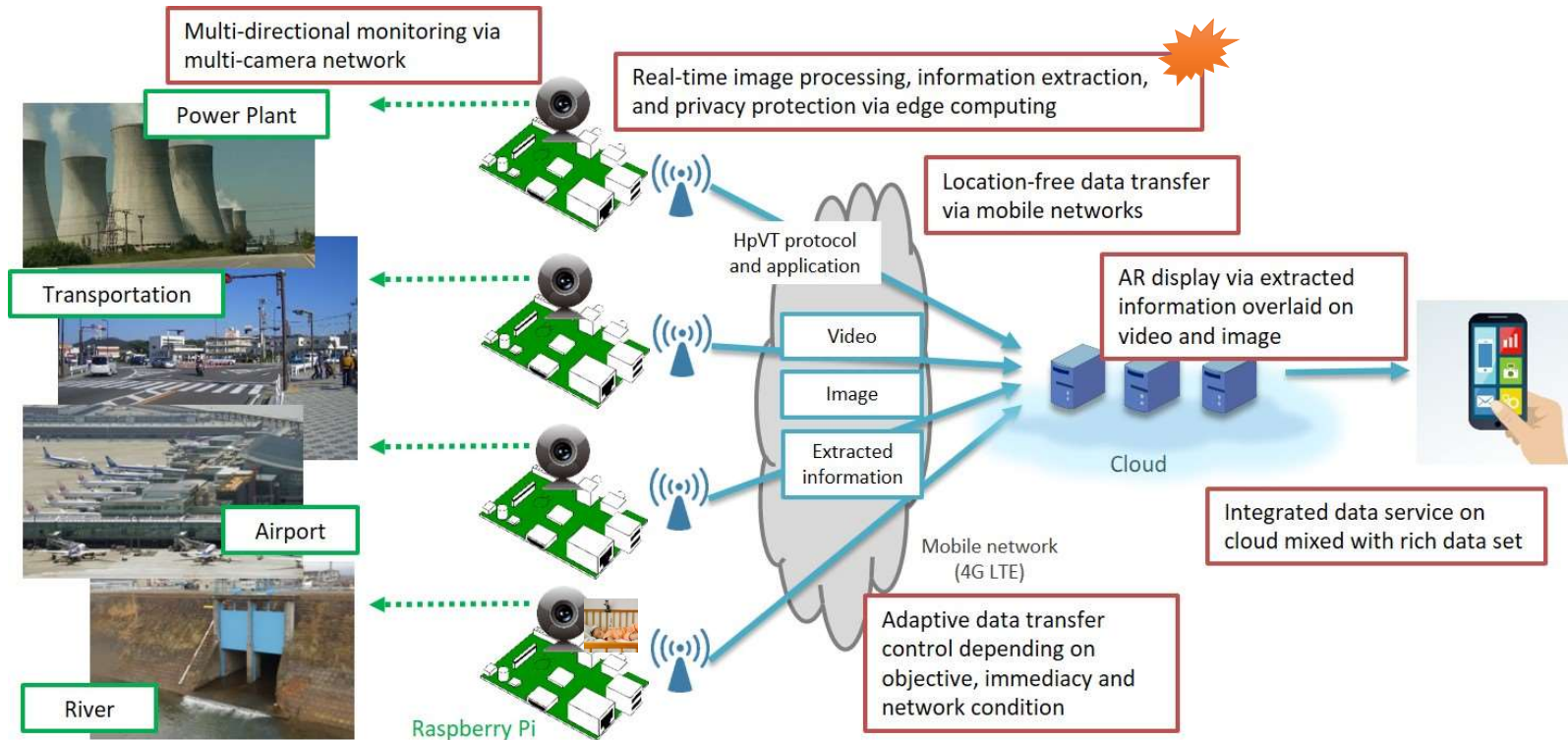


Occurrence of local heavy rain in each decade since 1976.

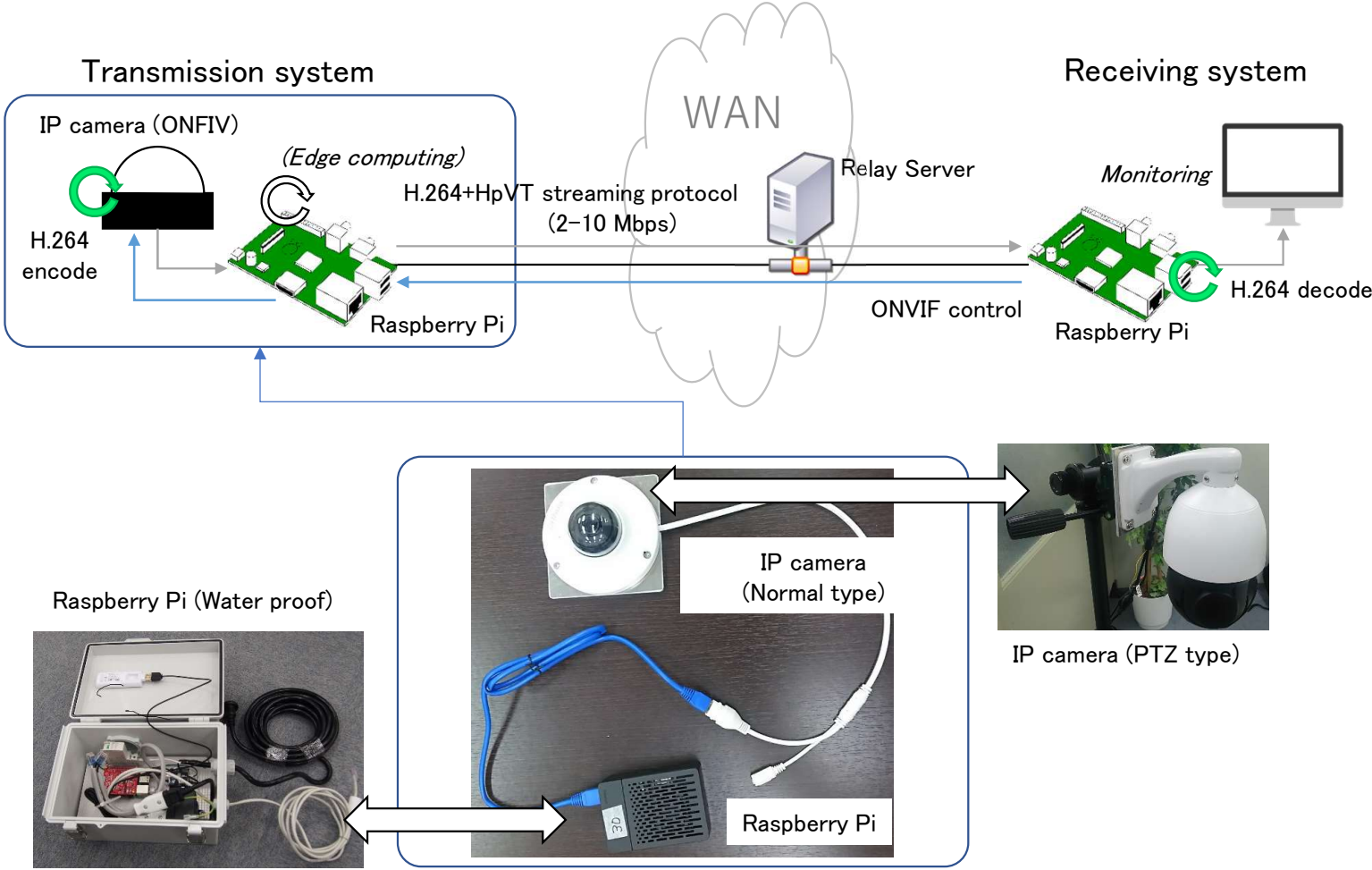
Resilient Natural Disaster Mitigation Concept: Cyber-Physical



Concept of “Visual IoT”

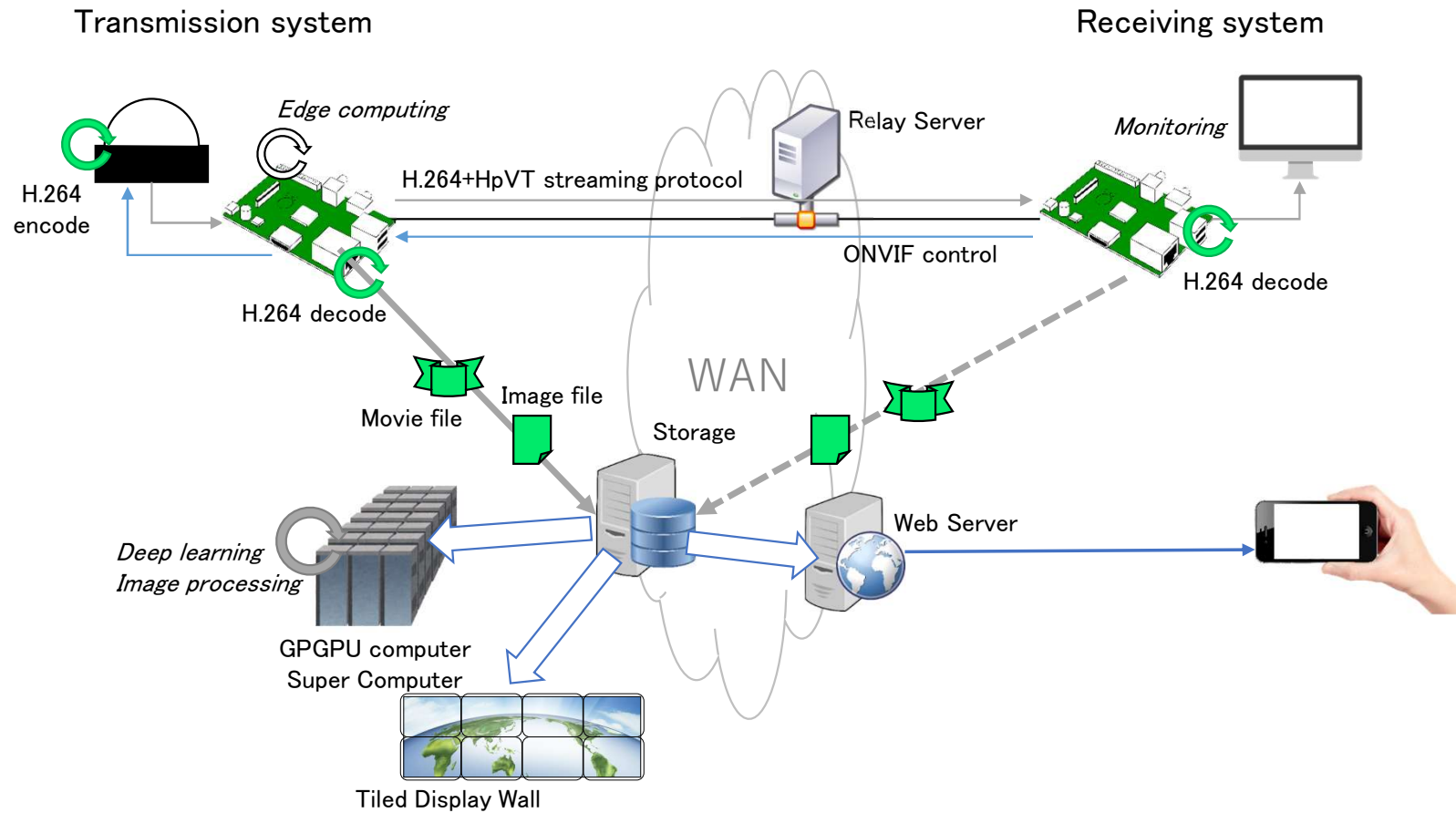


Visual IoT System Configuration



Visual IoT Implementation

expansion to AI and large-scale visualization

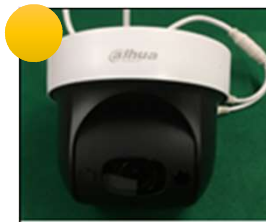


Commercial IP camera ONVIF (profile S) required



300 – 1,500 USD

Desk-top type



Japanese lantern type



Dome type

Barrett type

● PTZ (Pan-Tilt-Zoom)

System

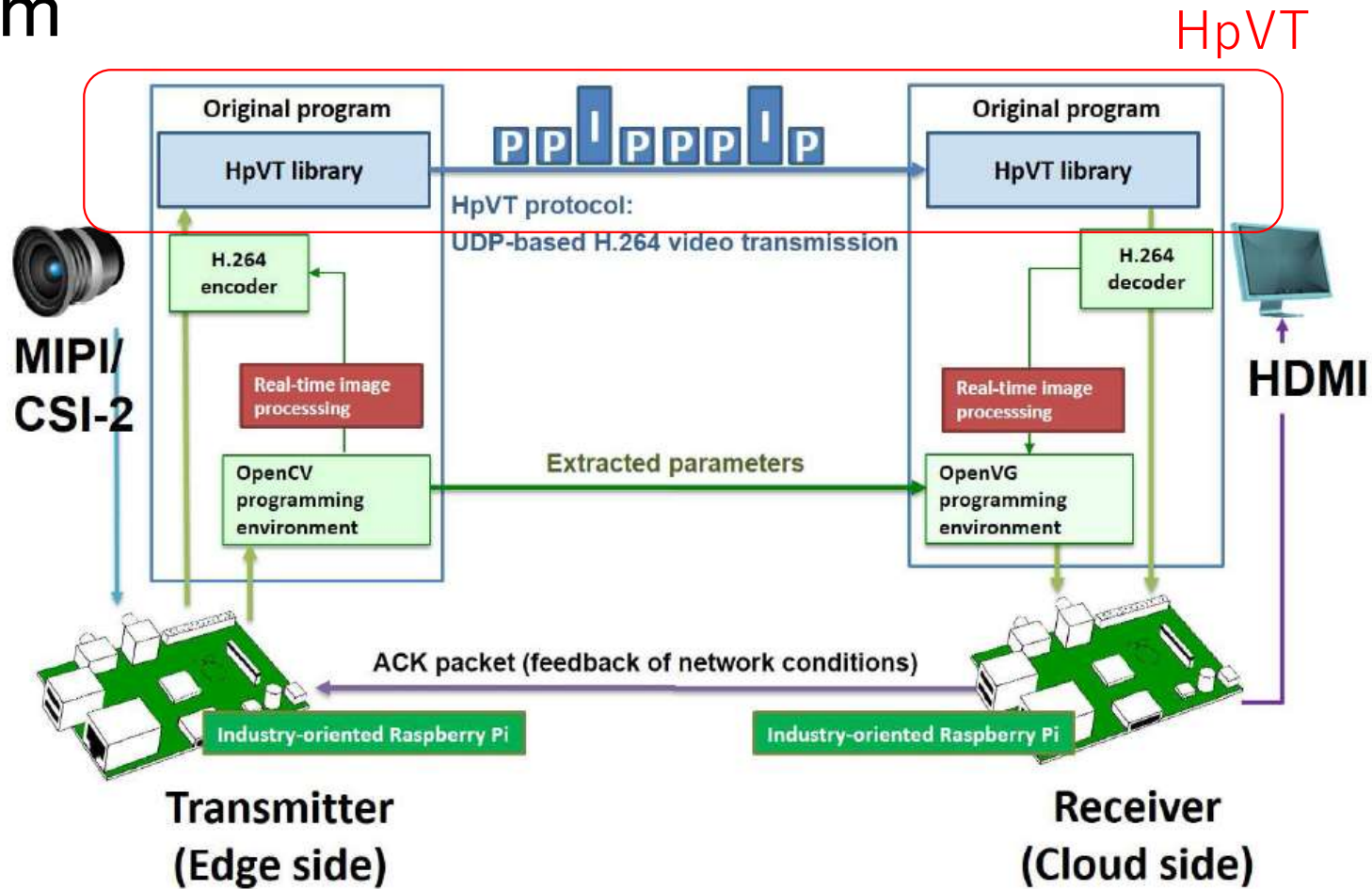


Fig. 1: A schematic picture of the HpVT protocol and HpVT application.

Overview of transmission and receiving video system

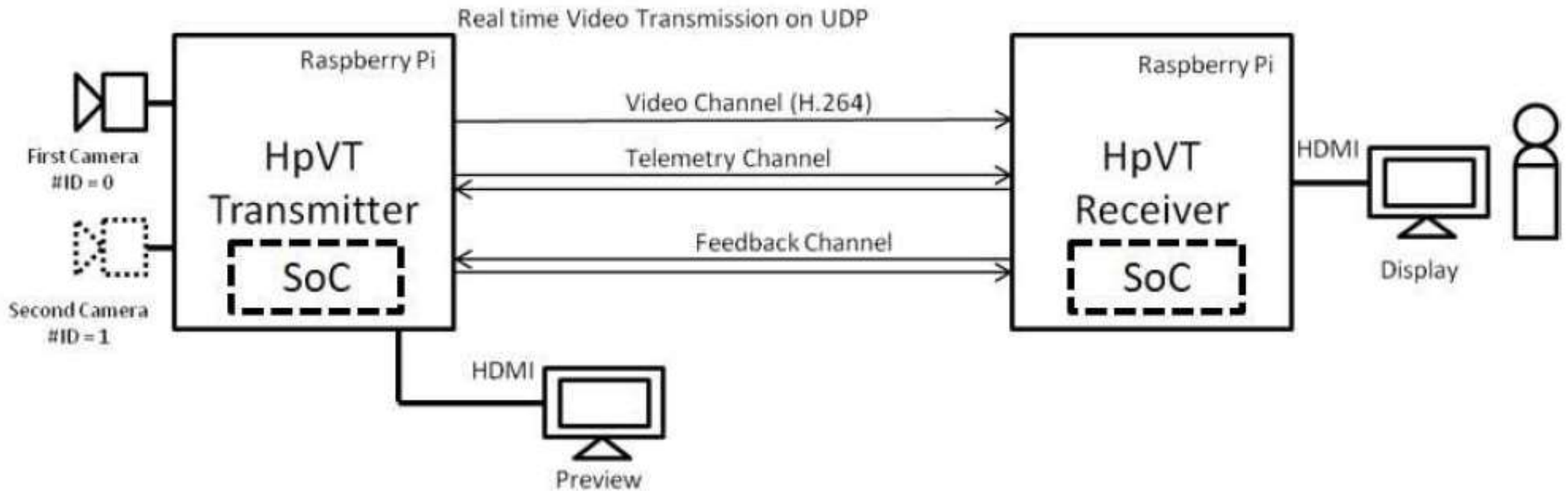


Fig. 2: Overview of transmitting and receiving video system.

Specification of a PTZ Camera

Hikvision: DS-2DE4425IW-DE
(about 200 US dollars)

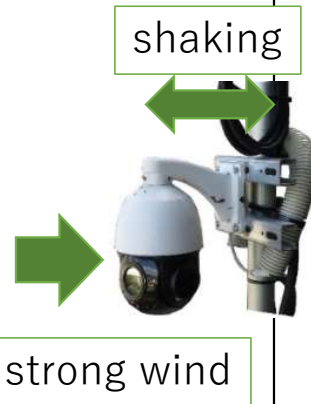


Camera Specification

Provider	HIKVISION
Model	DS-2DE4425IW-DE
Min. / Max. angle (Pan)	$-180^\circ / +180^\circ$
Pan range (p)	Normalized as $-1 \leq p \leq 1$
Min. / Max. angle (Tilt)	$-15^\circ / +90^\circ$
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)	1950 pixels
Focal length (at max. zoom level)	38025 pixels

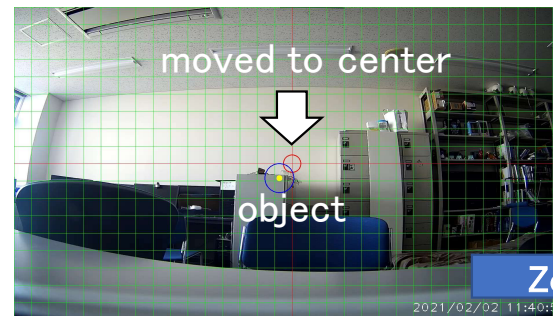
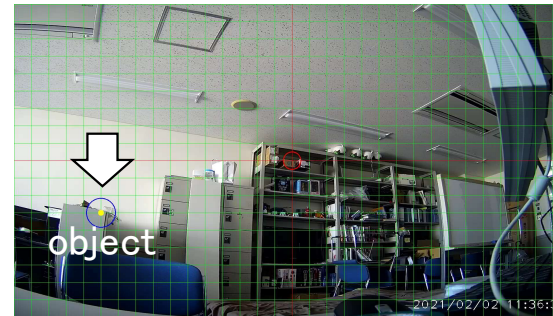
Customization of Visual IoT technique

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

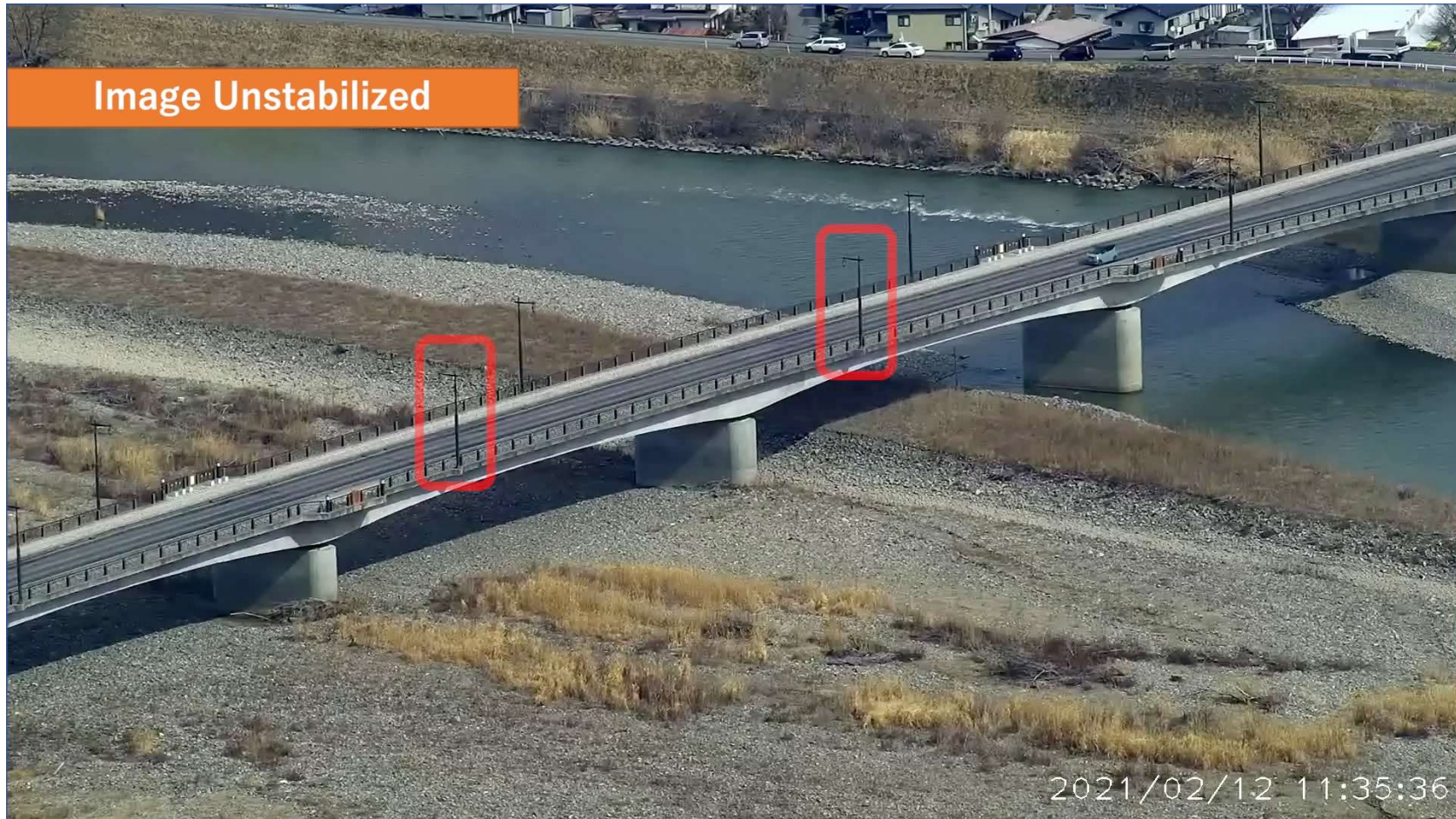
Results – Stabilized Examples of an Insect’s eye – Normal movie



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



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

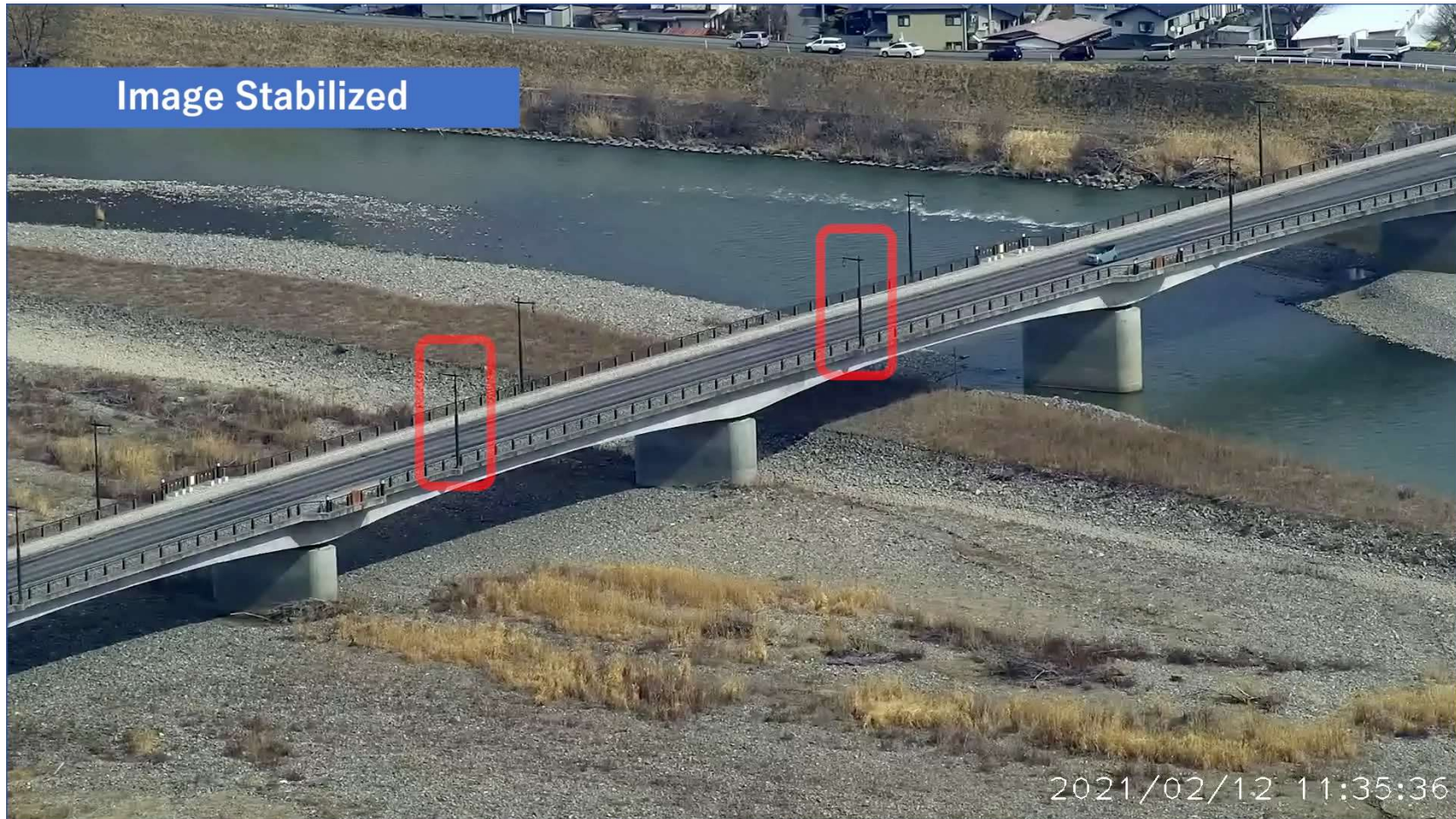


2021/12/15

The 24th International Symposium On Wireless
Personal Multimedia Communications -WPMC2021-

18

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



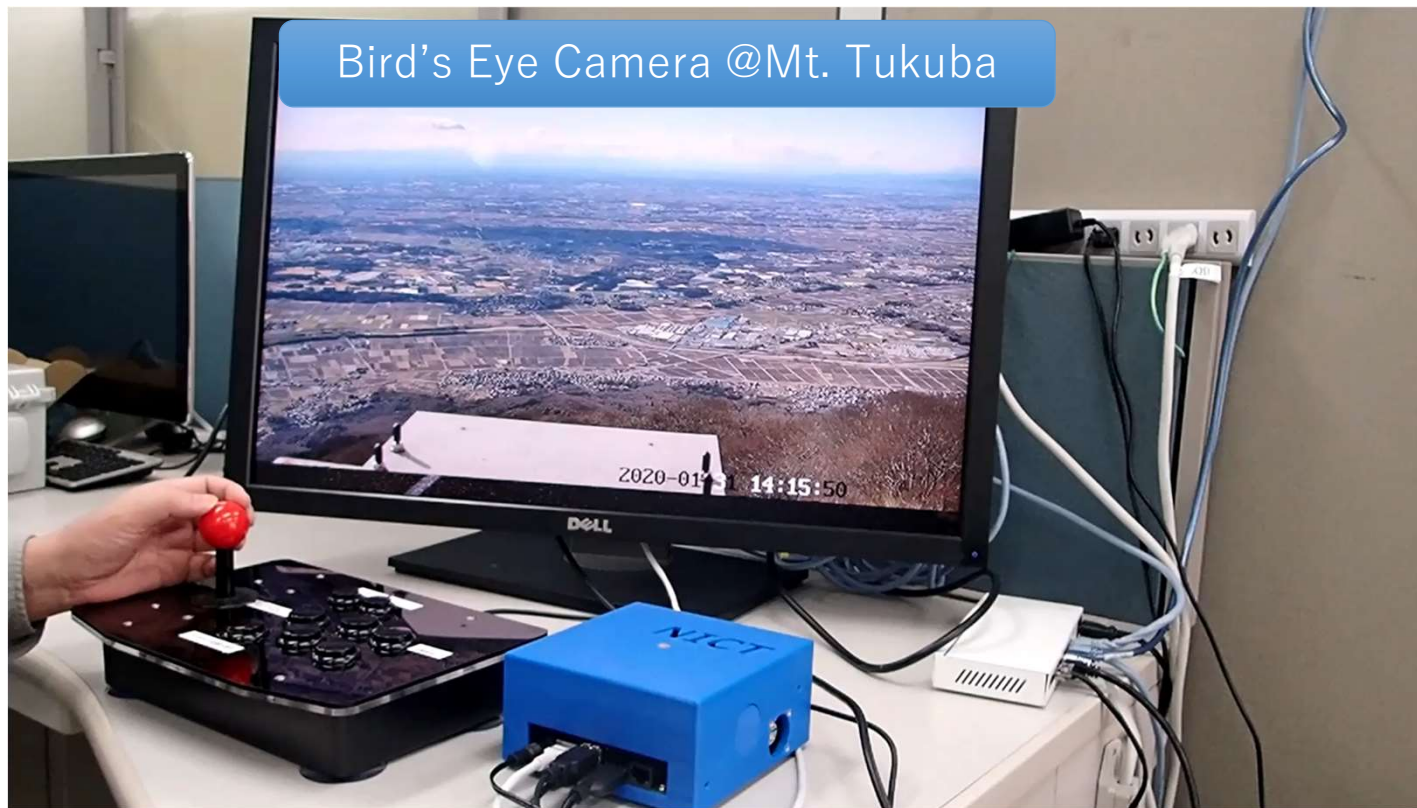
2021/12/15

The 24th International Symposium On Wireless
Personal Multimedia Communications -WPMC2021-

19

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



Chikuma city, Nagano, Japan

Chikuma ANZU project: Visual IoT system

2022/03/07 11:59:08

5columns

The image displays a grid of 17 live video feeds from various locations in Chikuma, ANZU. Each feed includes a timestamp and a location name. The feeds are arranged in a grid with 5 columns. Each feed includes a timestamp and a location name.

Location	Timestamp
Amenomiya	2022/03/07 11:58:19
Inariyama	2022/03/07 11:57:24
JoyamaPark	2022/03/07 11:58:57
Kamitokuma	2022/03/07 11:58:26
KamiyamadaCC	2021/10/01 00:03:59
KamiyamadaTC	2022/03/07 11:57:54
Kurashina	2022/03/07 11:57:52
Mori	2022/03/07 11:58:19
MoriShogunzuka	2022/03/07 11:58:52
Obasute	2022/03/07 11:52:27
ObasutePark	2022/03/07 11:58:55
Senbonyanagi	2022/03/07 11:57:29
Togura	2022/03/07 11:49:02
Yawata	2022/03/07 11:57:47

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



Amenomiya, Chikuma, Nagano (Japan)

Detection

[8] var:2.173,mag:1.29,area:498,V:228
[7] var:2.662,mag:1.18,area:728,V:227

Autonomous Smoke Detection

[6] var:0.105,mag:0.69,area:730,V:143

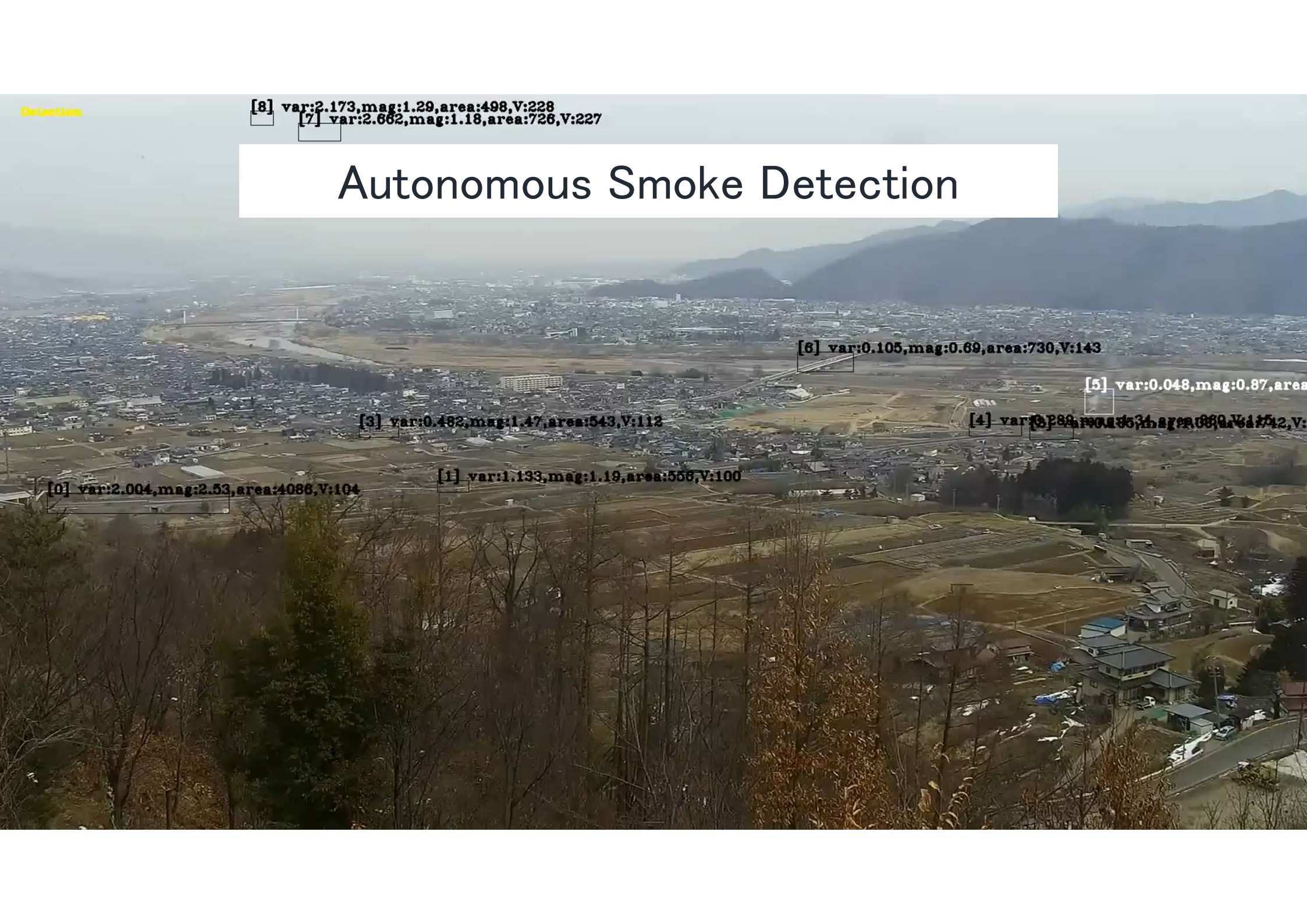
[5] var:0.048,mag:0.87,area:...

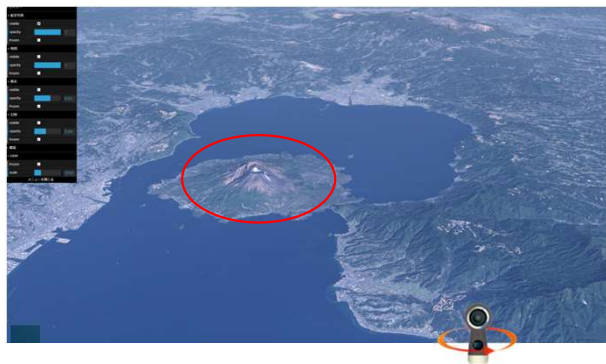
[3] var:0.482,mag:1.47,area:543,V:112

[4] var:0.289,mag:0.53,area:669,V:742

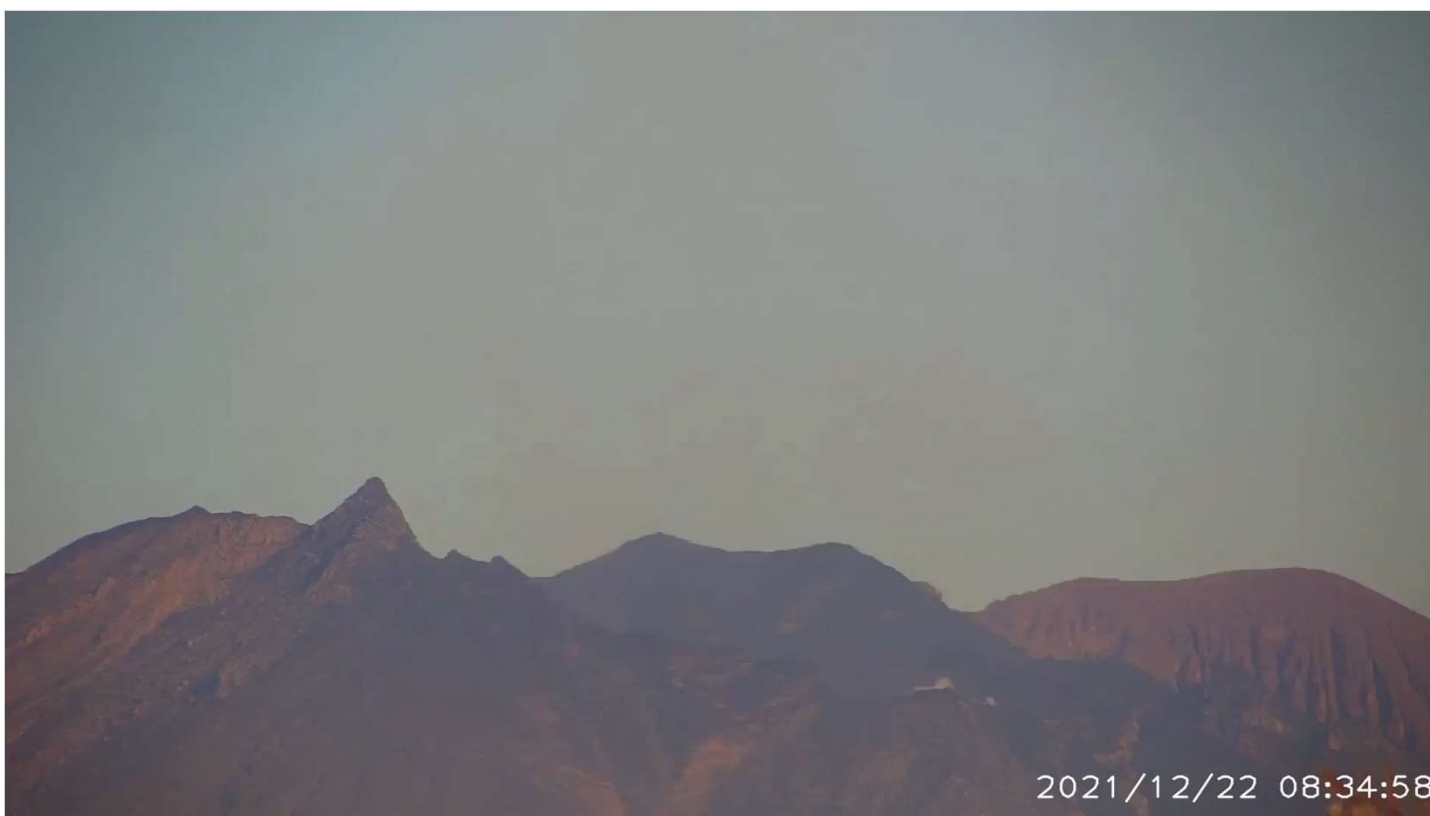
[0] var:2.004,mag:2.53,area:4088,V:104

[1] var:1.133,mag:1.19,area:556,V:100





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	○	×

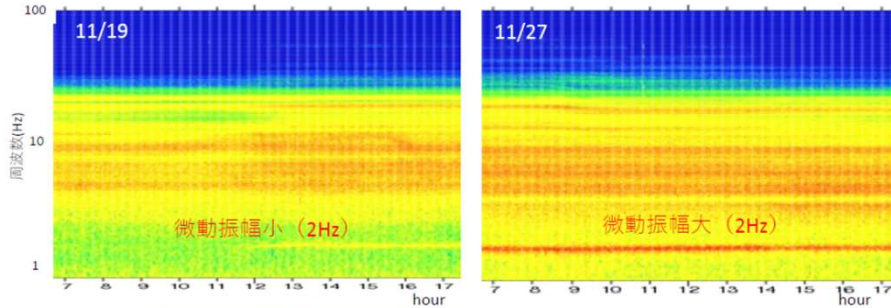
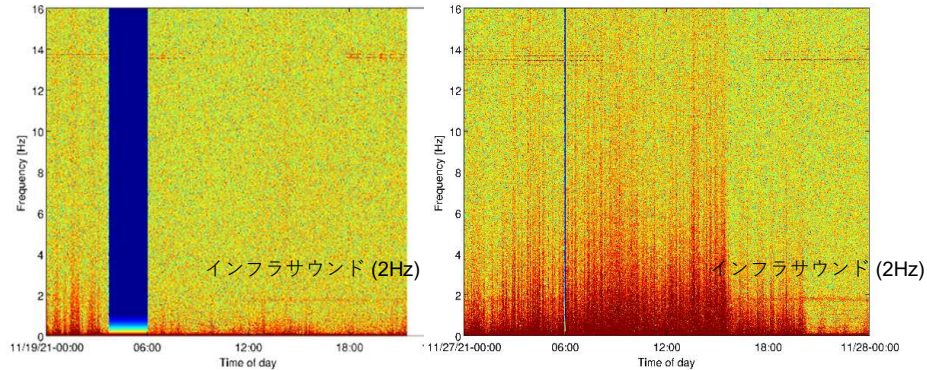
Daytime
Nighttime

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

200W solar panel



DMFC
direct methanol fuel cell

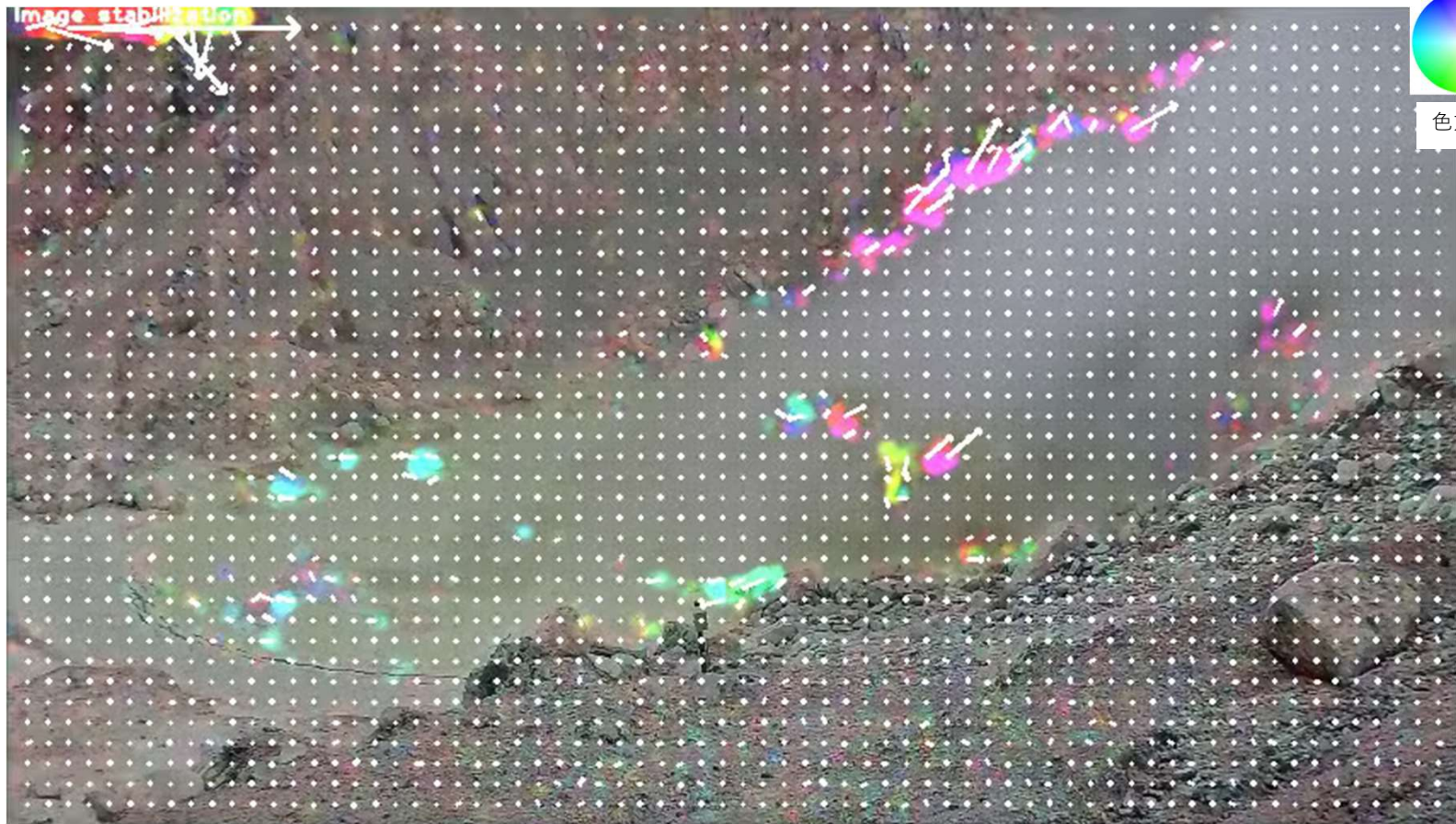


lou-yama volcano @Miyazaki, Japan

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.