

iCHE2024

ASIAM infra

ALL
SOLUTION for
INFRASTRUCTURE &
ASSET
MAINTENANCE

AI for Pavement Inspection: a rapid response after flood

Dr. Ekarin Lueangvilai

Don Muang Tollway Public Company
Limited

Asiam Infra Company Limited

DR. EKARIN LUEANGVILAI

- Structure Engineer
- 10 years with Expressway Maintenance, Expressway Authority of Thailand (EXAT)
- 12 years as Researcher in R&D for EXAT and Don Muang Tollway PLC.
- General Manager for “ASIAM Infra Co.,Ltd”
- Focus on inspection and maintenance of road and infrastructure
- Always looking for inspection technique to make life better



Roadways and Structures need inspection periodically to ensure public safety.



5 October 23, Kampong Phet, North of Thailand



2 spans gone by flood
60 m

5 ต.ค. 2566 11:27 น.

ข่าว > ทวีไทย > เหนือ | ไทยรัฐออนไลน์

สะพานวังแชม ถล่มลงแม่น้ำปิงตัดขาดชาวบ้าน 2
ตำบลที่กำลังแพงเพชร (คลิป)



สิ่งปิดสะพานข้ามแม่น้ำกก เชียงราย ตอม่อทรุดตัว แฉก ร้าวหนัก หลังน้ำท่วมใหญ่

วันที่ 29 สิงหาคม 2567 - 11:47 น.

[Facebook](#) [Twitter](#) [LINE](#) [Copy Link](#)



29 August 24, Chiang Rai
, North of Thailand

The need of river bed scan
Underwater pier scan
Scoring control





2 สค 2567 - 19:03 น.

สวัสดีเย็นวันศุกร์! ถนนแจ้งวัฒนะทรุด เจ้าหน้าที่เอาแผ่นเหล็กมาปิดให้ชั่วคราว ก่อนที่ในเวลา 22:00 น. จะปิดการจราจรเพื่อจัดซ่อมถาวร

โคราชถนนทรุด ขุดค้นเป็นโพรงลึก 60 ซม. ชาวบ้านห้าม ไม่ปลอดภัย เจ้าหน้าที่งานเร่งแก้ด่วน

วันที่ 21 กรกฎาคม 2567 - 10:14 น.

[Facebook](#) [Twitter](#) [LINE](#) [Copy Link](#)





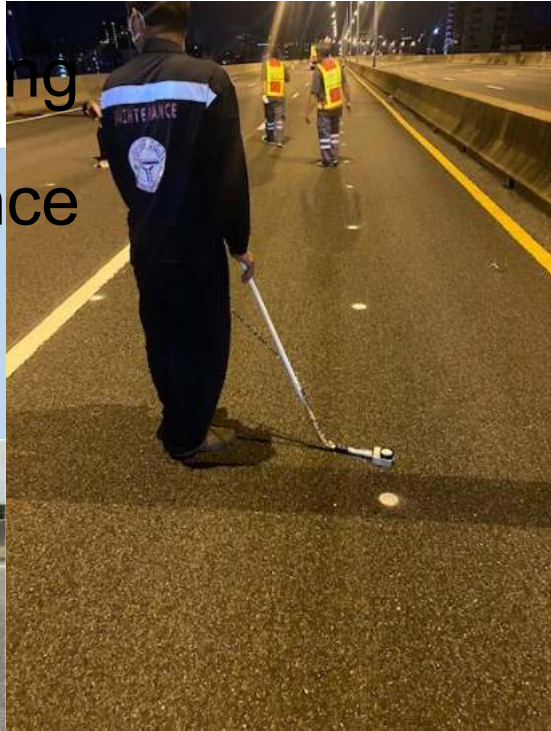


Friction by British
Pendulum

Road Marking
retroreflective



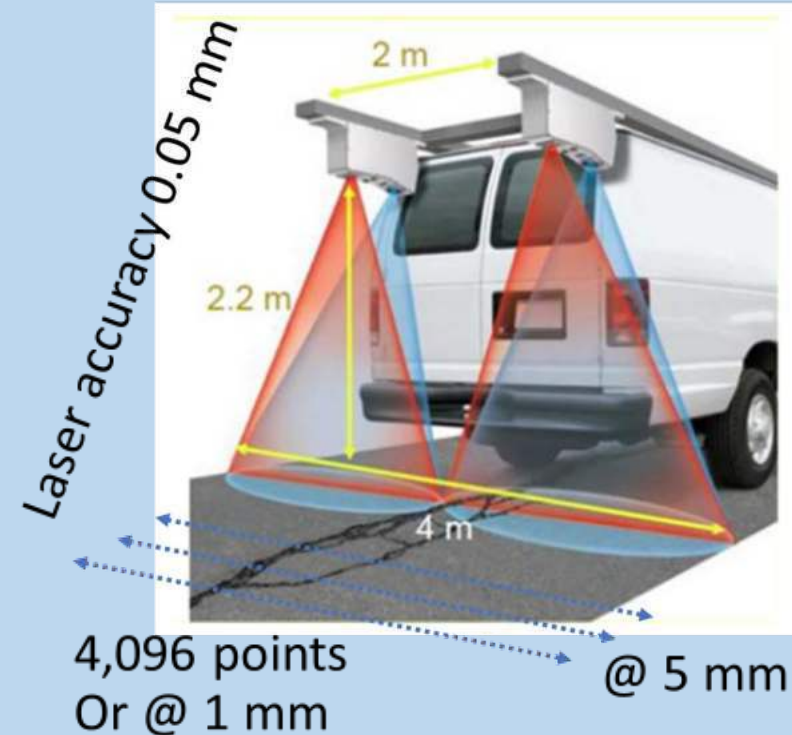
Street Lighting
Luminance



Are there the
better methods?

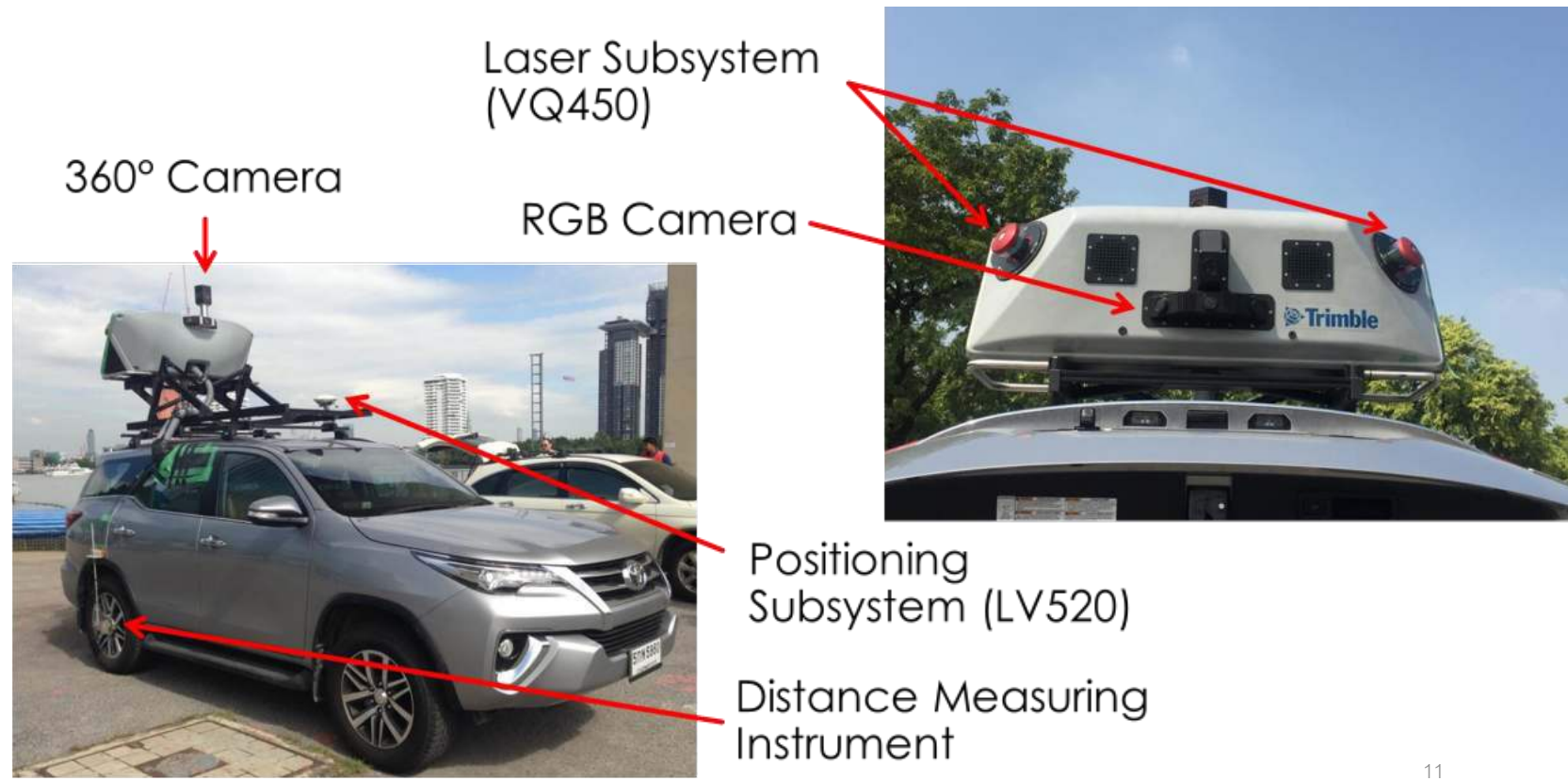
Rut Depth
Measurement

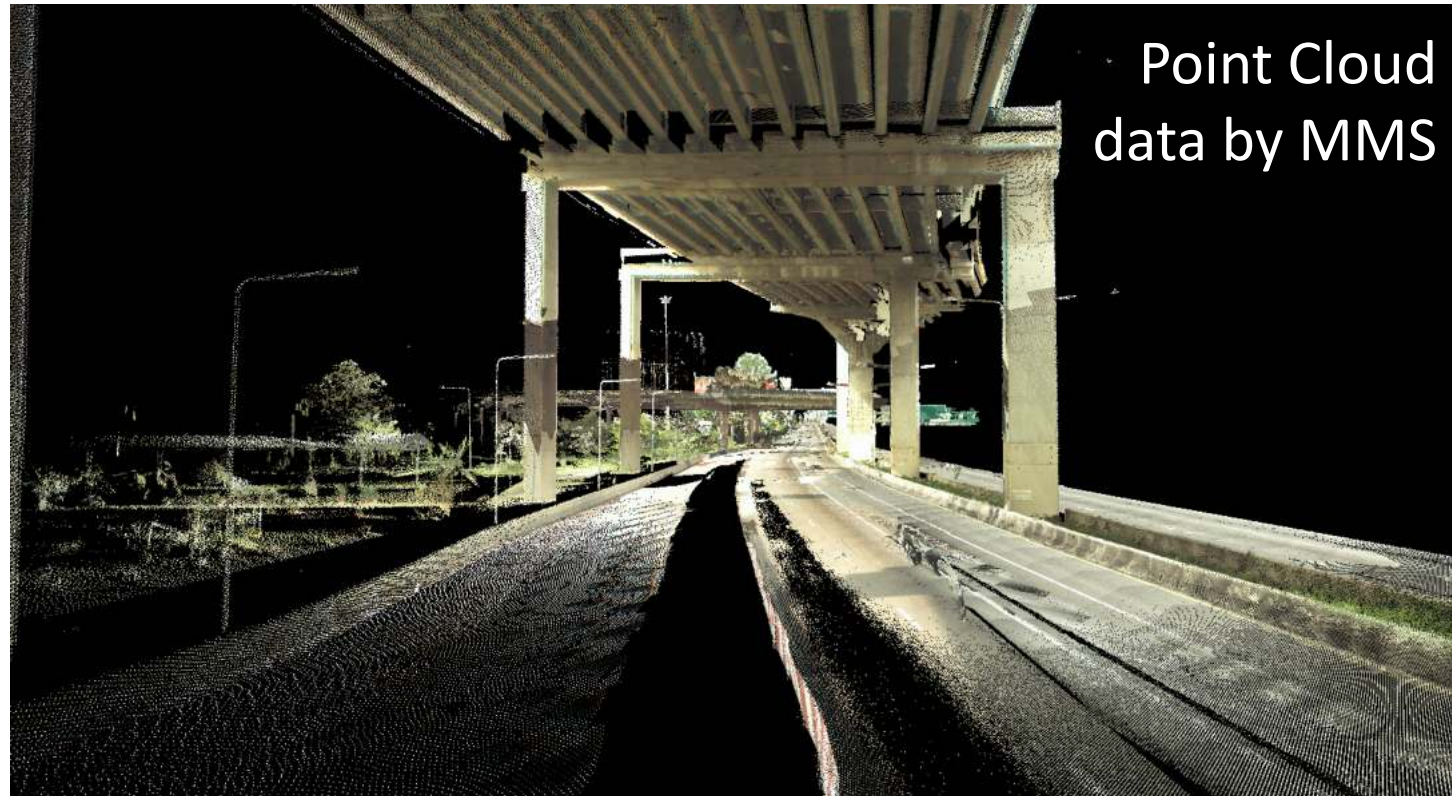




Big machine: Road laser scanner
 Resolution of 1x5 mm
 Mesh 5 x 5 cm = 500 points
 Customized for IRI and Rut depth measurement

The bigger machine: Mobile Mapping Laser Scanner





- High resolution , 1 M point/sec
- High Accuracy, ± 3 mm/200m
- Long Distance, 600 m max
- High speed, 80+ km/hr.
- GPS Base + 360° camera

- 360° point cloud data
- structure, pavement, everything
- Million of data handling
- **Data preparation, rectification**
- Machine of the Future



- Complicate Machine: High accuracy with million of Data
- Any simple measurement tool: acceptable accuracy
- Dash Cam, Smart Phone
- Easter Egg Engineering Applications



*“Smart Phone:
Swiss army knife for the
21st century”*

Dash Cam
Roadway
Inspection



Very Fast
Inspection

(GPS) Location

Date & Time



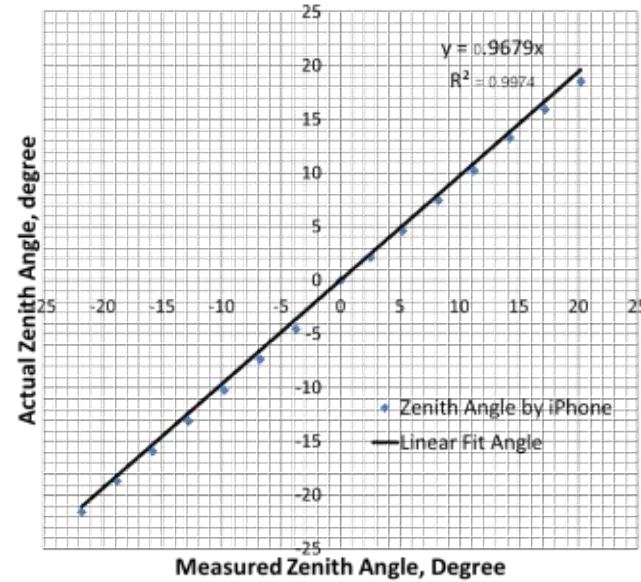
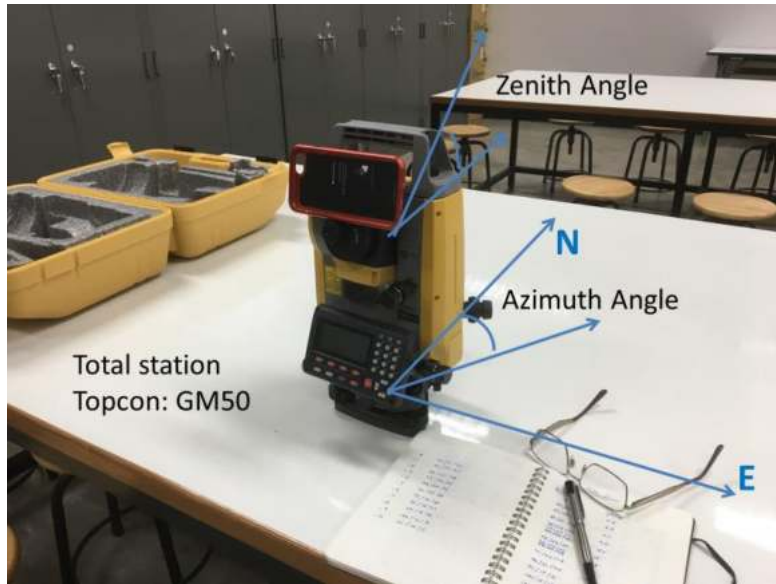
Azimuth

Picture



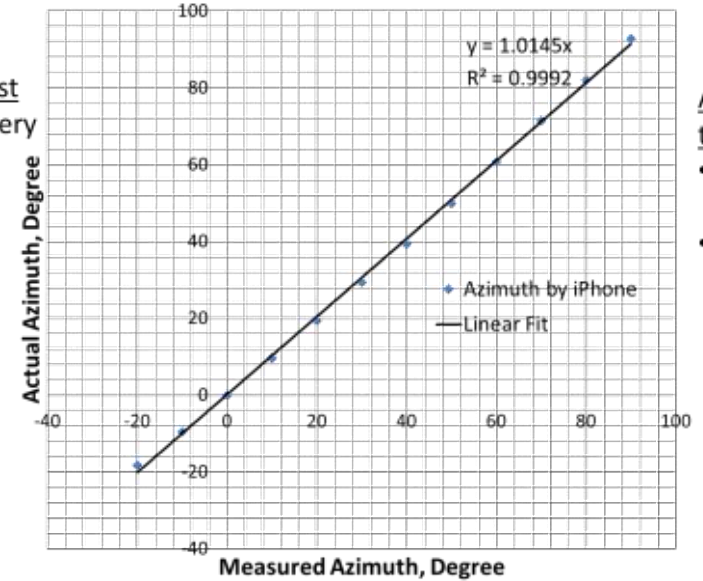
Mobile Application

- As good as actual instrument
- Very low cost (sometime FREE!)



Zenith Angle test

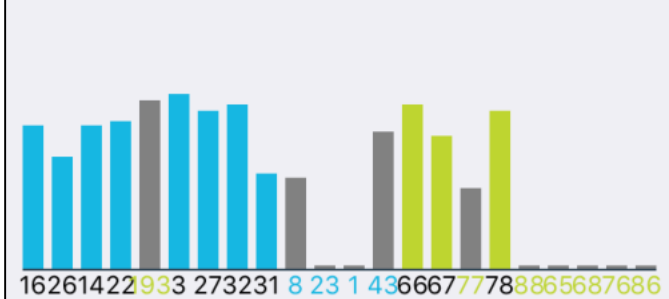
- Linearity is very good
- Accuracy is about 96.8%



Azimuth Angle test

- Linearity is excellent
- Accuracy is about 98.5%

Locked on Satellites: 11 of 22



Accuracy (CEP):

2.7m

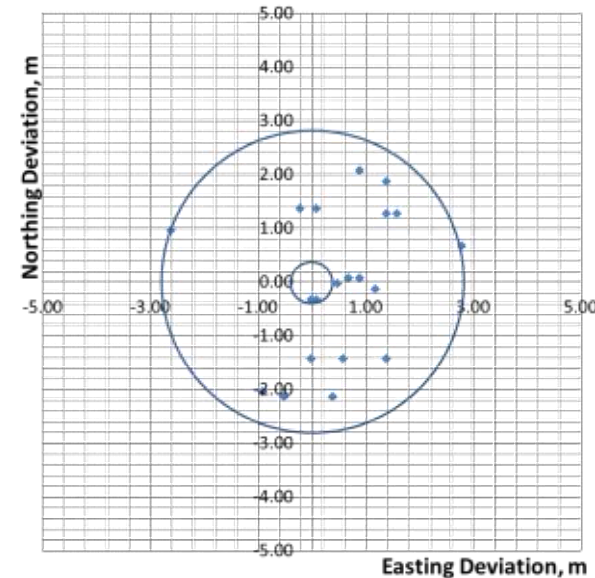
Horizontal

3.1m

Vertical

4.7m

Positional




Accuracy is 2.794 m
Average = 0.47 m
It is not good for inspection but good for asset localization

- GPS, Thermometer
- Tilt meter, Compass
- Accelerometer
- Gyro, Lidar
- **Very good linearity and accuracy**



Article
Accelerometers in Our Pocket: Does Smartphone Accelerometer Technology Provide Accurate Data?

George Grouios ^{1,*}, Efthymios Ziagkas ¹, Andreas Loukovitis ¹, Konstantinos Chatzinikolaou ¹ 
 and Eirini Koidou ²

¹ Department of Physical Education and Sport Science, Aristotle University of Thessaloniki, 57001 Thessaloniki, Greece
² Department of Physical Education and Sport Science-Serres, Aristotle University of Thessaloniki, Agios Ioannis, 62110 Serres, Greece

- Also good tri-axle accelerometer
- Valid and reliable devices for estimating linear accelerations

| | USA | KOREA | CHINA |
|--|--------------------------------|--|--------------------------------|
| Property | Smartphone 1 | Smartphone 2 | Smartphone 3 |
| Sensor maker | Bosch Sensortec | STMicroelectronics | STMicroelectronics |
| Sensor Model | BMI260 | LSM6DSL | LSM6DSM |
| Phone Maker, model | iPhone 12 Pro Max, 5G, IOS 14 | Samsung Galaxy S21 Ultra, 5G, Android 11 | Huawei P Smart, 5G, Android 10 |
| Type | MEMS | MEMS | MEMS |
| Sensitivity error | ±0.4% | ±0.4% | ±0.4% |
| Acceleration Range | ±2/±4/±8/±16 g | ±2/±4/±8/±16 g | ±2/±4/±8/±16 g |
| Angular Range | ±125/±245/±500/±1000/±2000 dps | ±125/±245/±500/±1000/±2000 dps | ±125/±250/±500/±1000/±2000 dps |
| Linear acceleration zero-g level offset accuracy | ±20 mg | ±40 mg | ±40 mg |
| Linear acceleration self-test output change | N/A | 90–1700 mg | 90–1700 mg |
| Linear acceleration output data rate | 12.5 Hz ... 1.6 kHz | 1.6 ... 6664 Hz | 1.6 ... 6664 Hz |
| Rate noise density in high performance mode | 160 μg/√Hz 0.008 dps/√Hz | 4 mdps/√Hz | 3.8 mdps/√Hz |
| Acceleration g for 0.2 ms | 10,000 g | 10,000 g | 10,000 g |
| Analog supply voltage | 1.71 V to 3.6 V | 1.71 V to 3.6 V | 1.71 V to 3.6 V |

Using smartphones as a very low-cost tool for road inventories

S. Higuera de Frutos*, M. Castro

Dept. Transportes, E.T.S.I.C.C.P., Universidad Politécnica de Madrid, C/ Prof. Aranguren s/n, 28040 Madrid, Spain



Fig. 1. Mounting the smartphone on the driving mirror.

Inventory

ROADROID CONTINUOUS ROAD CONDITION MONITORING WITH SMART PHONES



Fig. 3 a) left and b) right – The 3-rd prototype 2011

Roughness: IRI

CITY-WIDE ROAD DISTRESS MONITORING WITH SMARTPHONES

Christoph Mertz, Srivatsan Varadharajan, Sobhagya Jose, Karan Sharma, Lars Wander, and
Jina Wang
Carnegie Mellon University

Damage

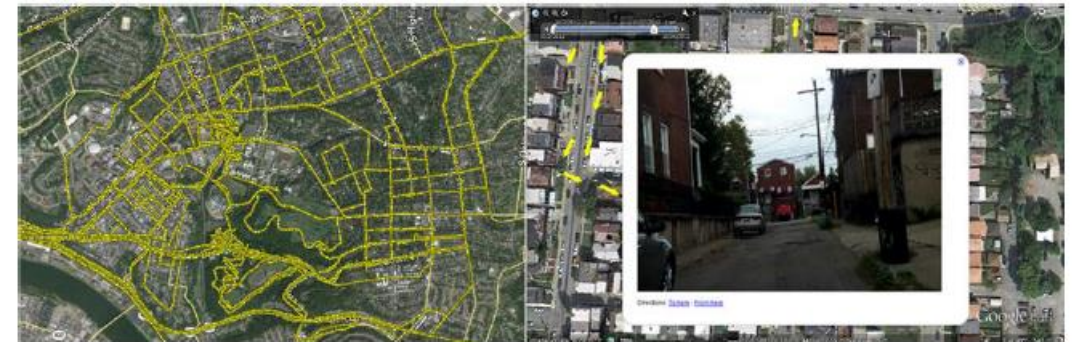


Figure 3 Example of road image displayed on Google Earth. Left: The streets where images were collected

EVALUATION OF A SMARTPHONE ROUGHNESS METER

M R SCHLOTJES¹, A VISSER², and C BENNETT¹

¹The World Bank Group, 14 Martin Place, Sydney, 2000, NSW, Australia



A Study on the Use of Smartphones for Road Roughness Condition Estimation

Viengnam DOUANGPHACHANH^a, Hiroyuki ONEYAMA^b

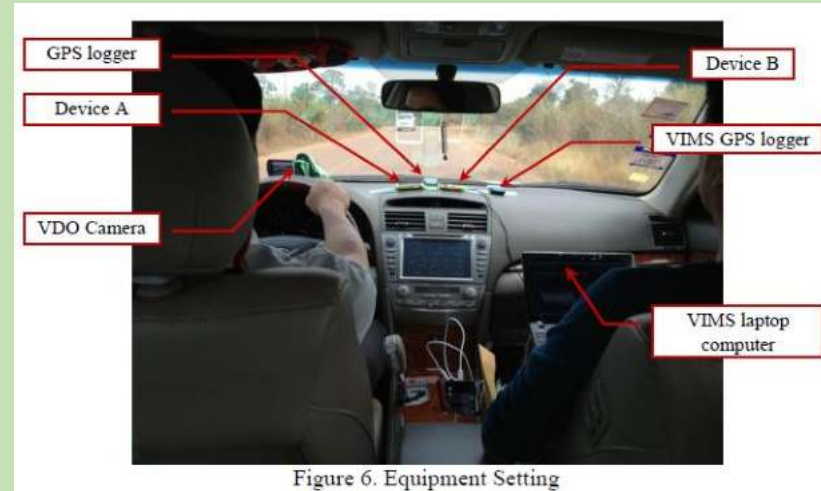


Figure 6. Equipment Setting

Development of a Road Monitoring and Reporting System Based on Location-Based Services and Augmented-Reality Technologies

Jia-Ruey Chang¹; Hui-Mi Hsu²; and Sao-Jeng Chao³

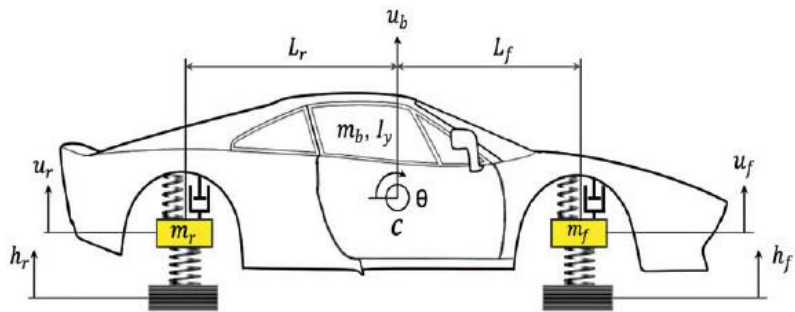
AR / AI for Inspection Works



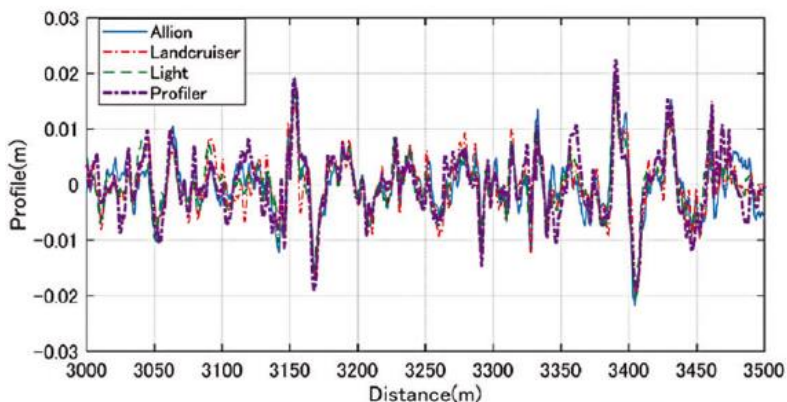
(i) Photos and reporting of defect



IRI Analysis



Half-car model



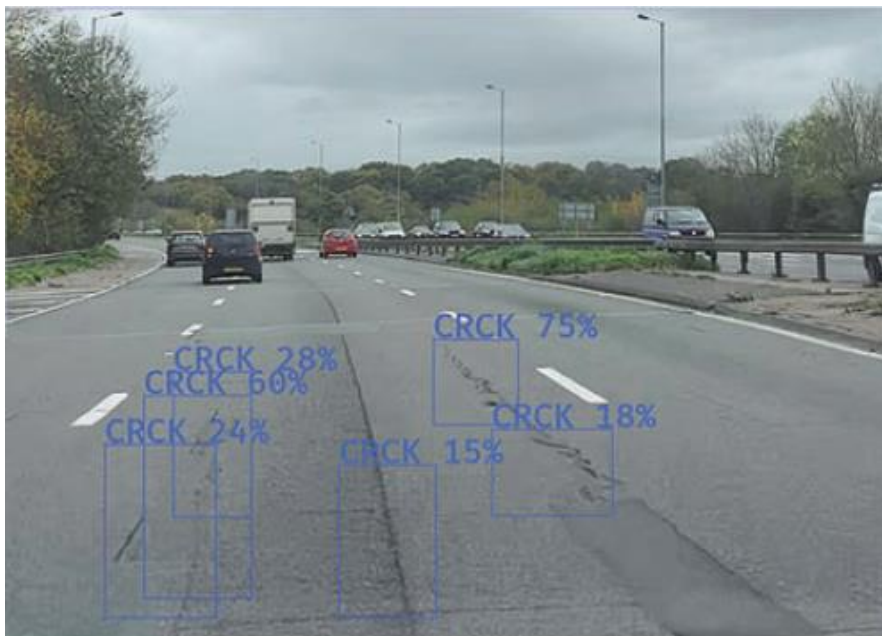
Estimated profile with 3 vehicles (3000-3500m)

Tomonori NAGAYAMA, boyu ZHAO and kai XUE. "Half car model identification and road profile estimation using vibration responses of a running vehicle". Journal of JSCE E1. Vol75, no. 1, 1-16, 2019.

IRI Analysis by Smartphone

- Use Sensors in Smartphone
- Half-car model (better Quarter-car Model)
- Applicable with Various kind of cars (Eco Car > SUV)
- Algorithm developed at University of Tokyo





AI Analysis

Road Distress Detection

- Deep learning AI engine
- Using actual image for AI training

Lets try..

Roadway Inspection

AI measurement for road distress etc. pot holes

IRI measurement using vehicle vibration (DRIMS)



M6 Elevated AC Pavement km 132+000 – 133+000


23 April 2024

DRIMS VIEWER ASIA

ASIAM
20240423_16020

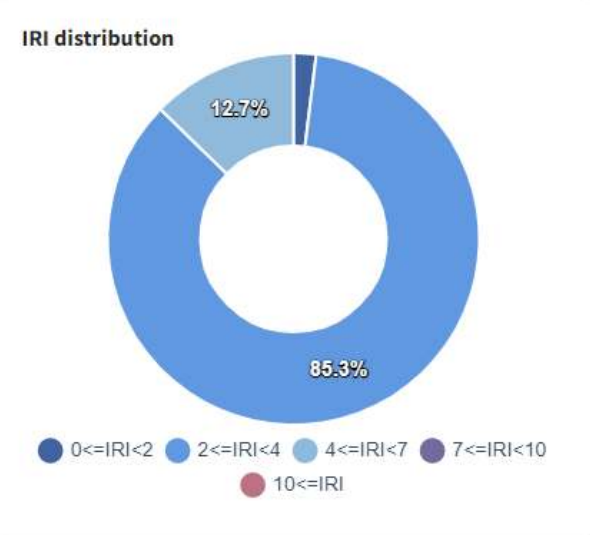
FROM
2024-02-07

Display options
Down
Lane 1



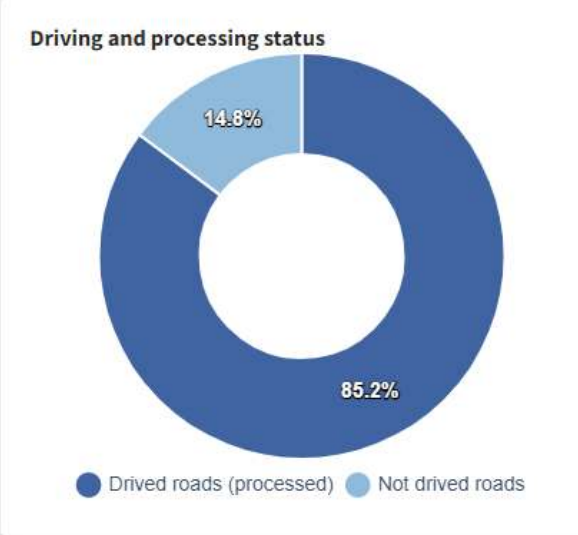
Detected damages
ALLIGATOR... 0
JOINT 0
PATCH 0

IRI distribution

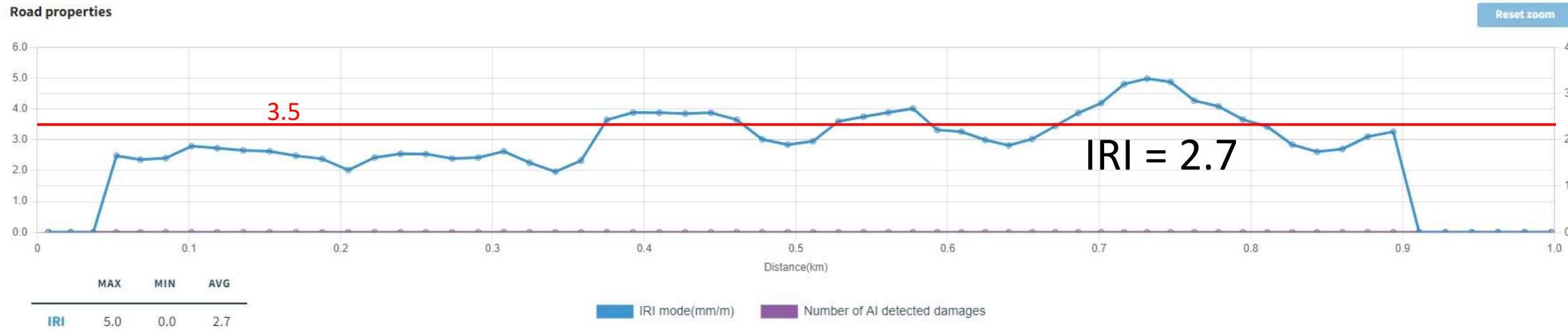


● 0<=IRI<2 ● 2<=IRI<4 ● 4<=IRI<7 ● 7<=IRI<10 ● 10<=IRI

Driving and processing status

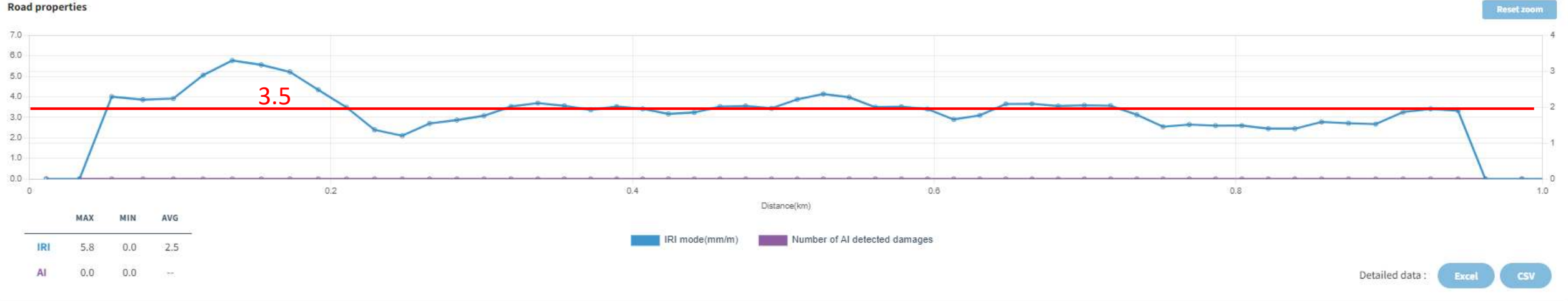
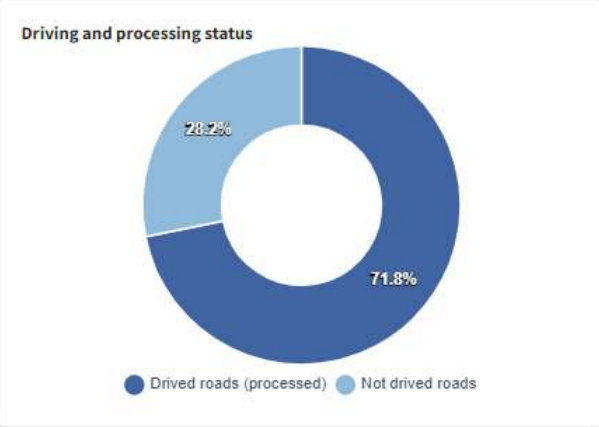
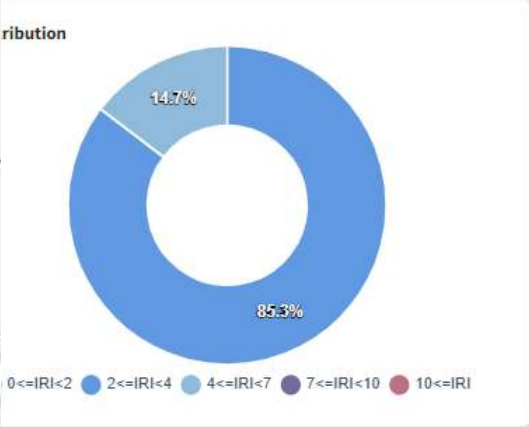
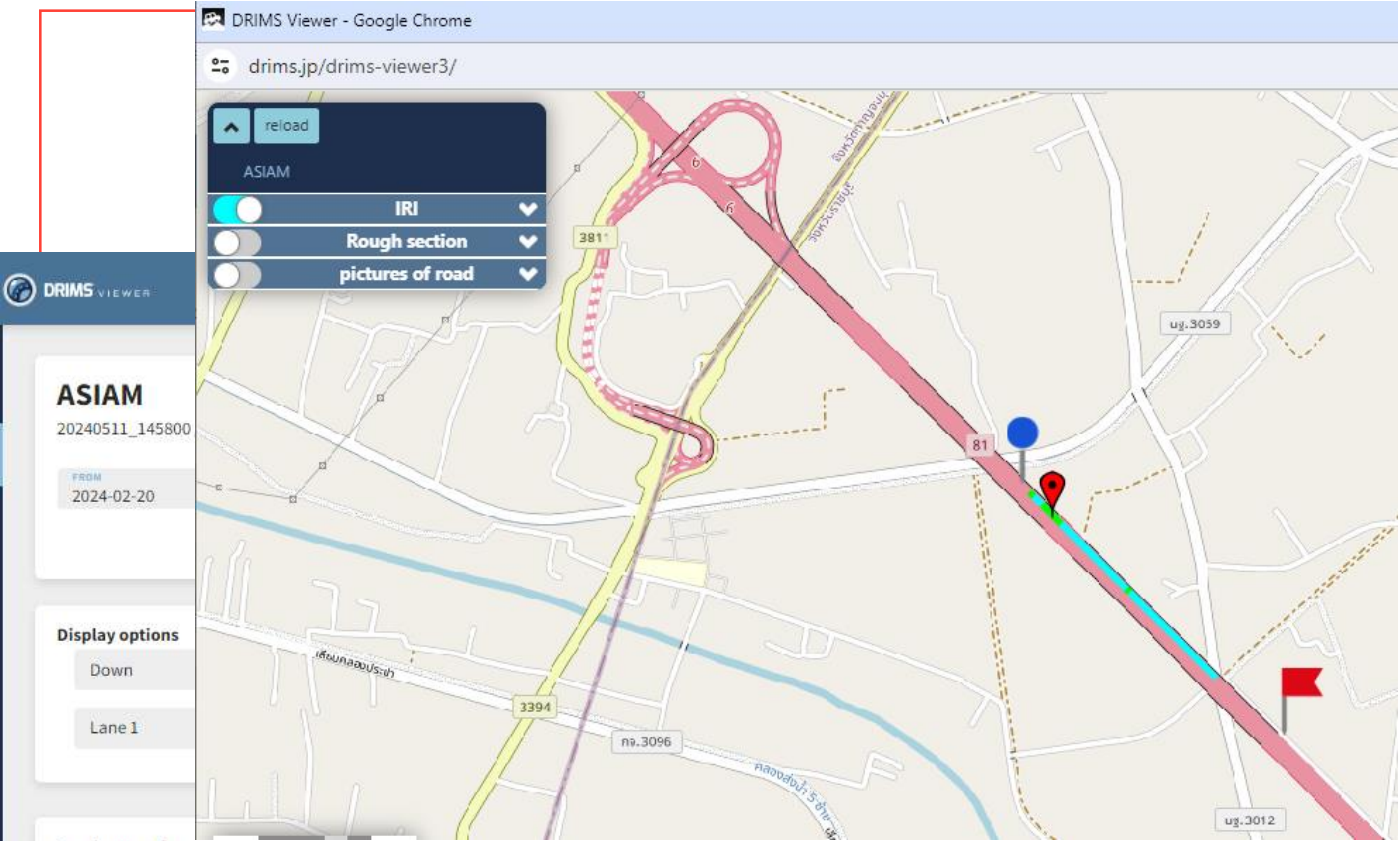


● Drived roads (processed) ● Not drived roads



M81 At grade AC Pavement km 87+000 – 86+000

11 May 2024



M6 and M81 are new
No pavement distress



DRIMS Viewer - Google Chrome
drims.jp/drims-viewer3/

reload
ASIAM
IRI
Rough section
pictures of road

Crack Detected !

Brightness: 0 Zero Reset

Keep zoomed
Keep moved

Shooting Date 2566/12/28 16:40:56
lat./lon. 13.959361, 100.626108
Detection Type Single Crack
Inspection required Enter comment

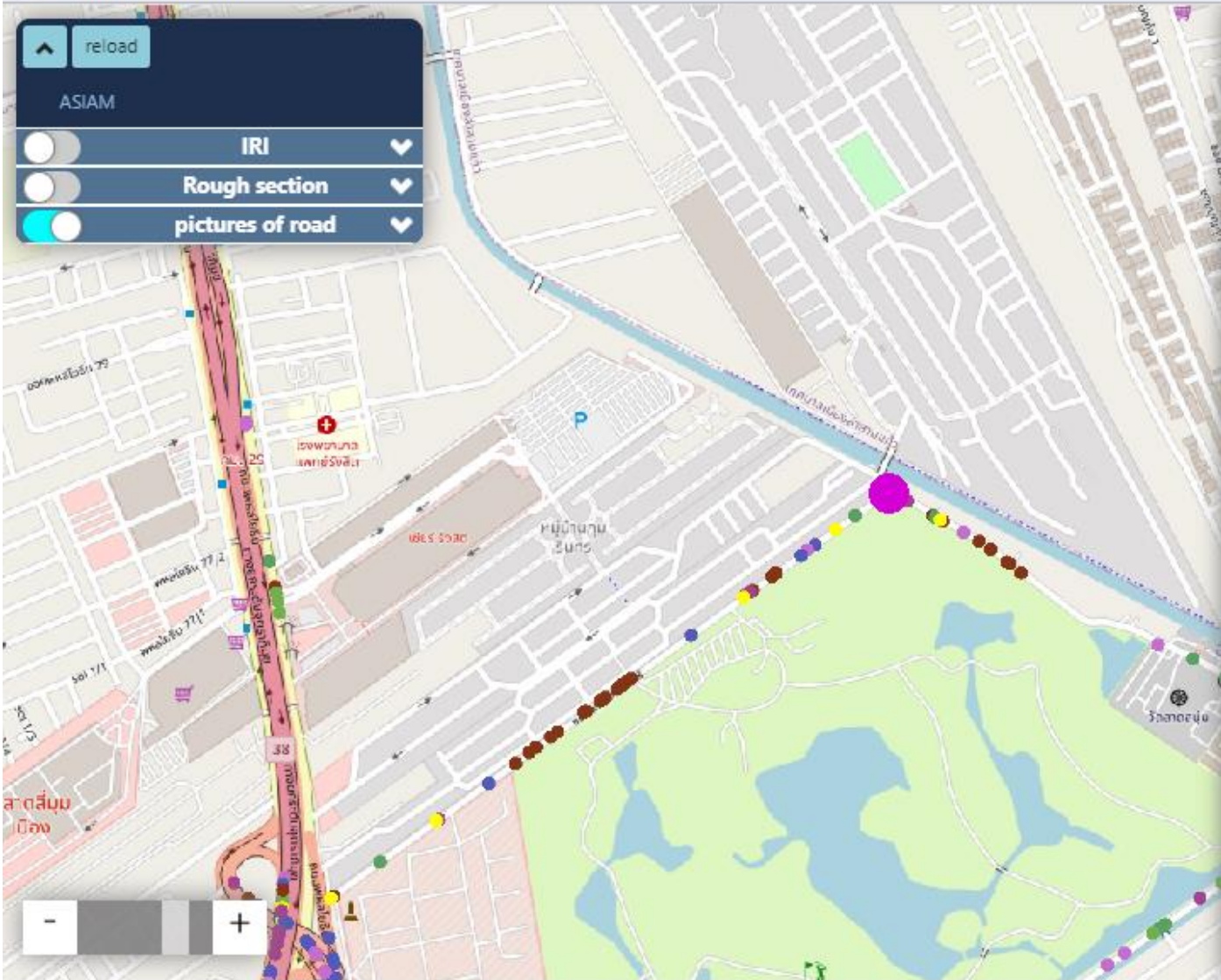
↑ reload

ASIAM

IRI

Rough section

pictures of road



It's work !!!



Brightness: 0 Zero Reset



- Keep zoomed
- Keep moved



Shooting Date 2566/12/28 16:39:51

lat./lon. 13.962361, 100.630407

Detection Type Single Crack

Inspection required

Enter comment

Flood Damages

Heavy rainfall causes flooding in Pattaya communities

By Pattaya Mail May 8, 2024

2368 0

Share on Facebook

Tweet on Twitter

Like 4

Post

8 May 2024



Heavy rainfall on Tuesday morning inundated several communities in Pattaya, with inner areas such as the Third Road submerged under floodwaters.

Decades-long chronic flooding plagues residents of East Pattaya

By Pattaya Mail July 18, 2024

1584 0

Share on Facebook

18 July 2024



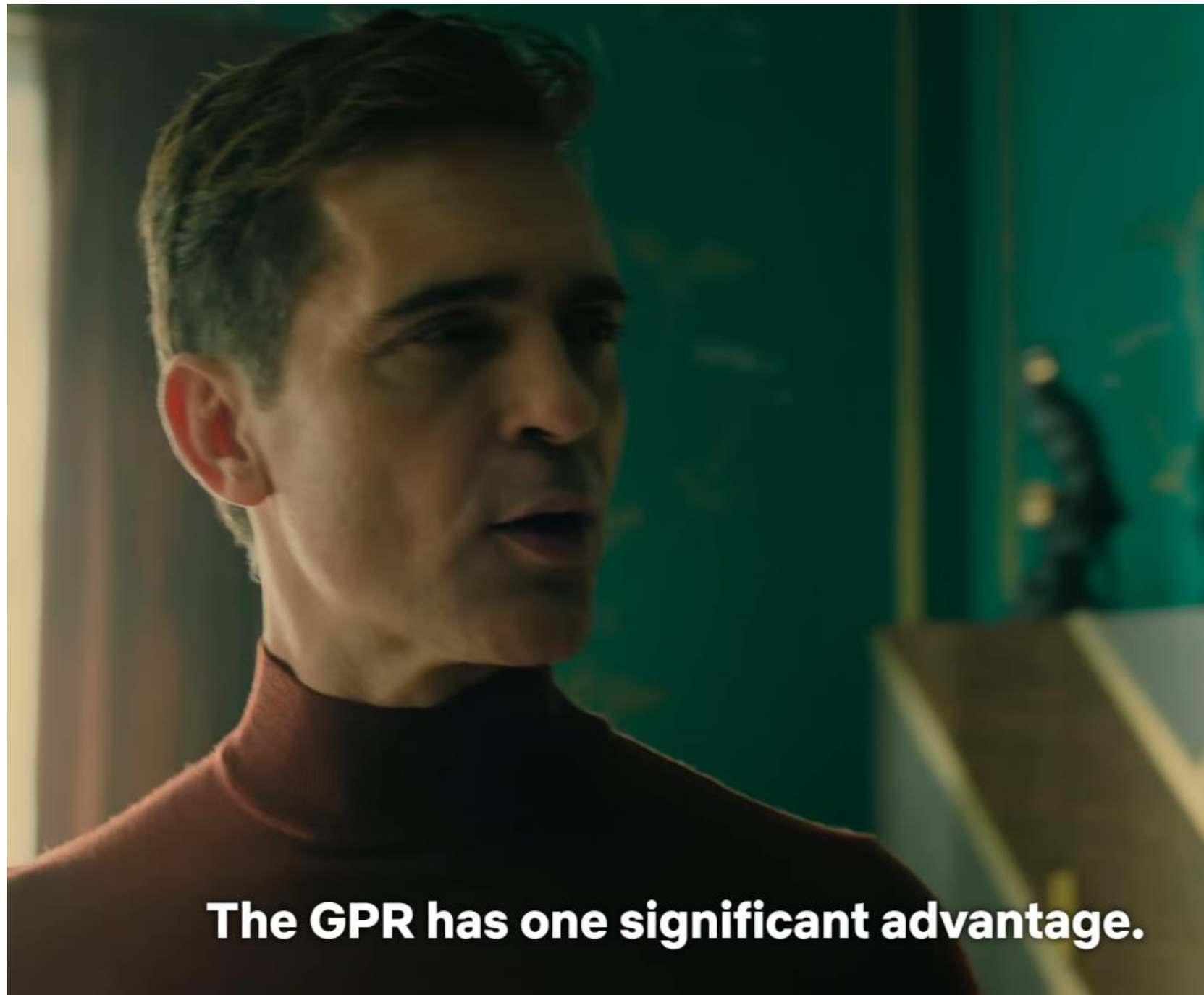
After a brief but intense downpour, water levels rose nearly one meter at the railway road near Khao Talo, Wat Tham Samakhi community, and Sukhumvit Road in front of the South Pattaya Highway Police Station.

Fast & Rapid
Road
Inspection
after FLOOD

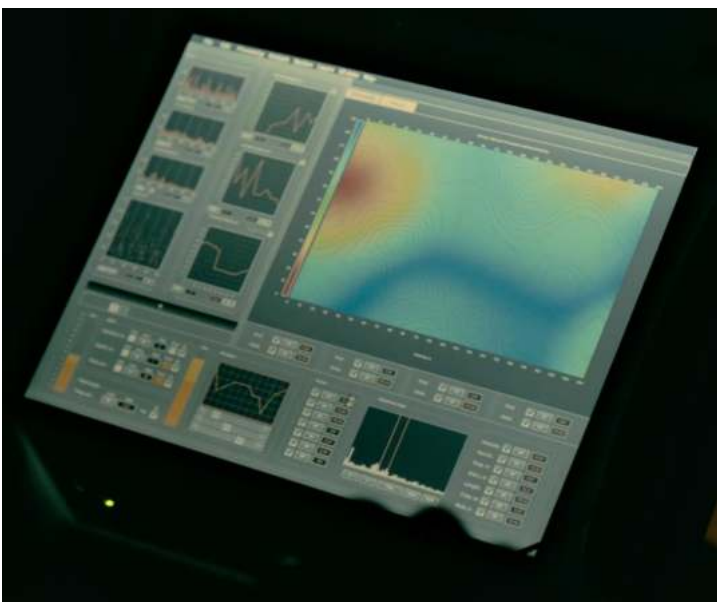
Flood Damages





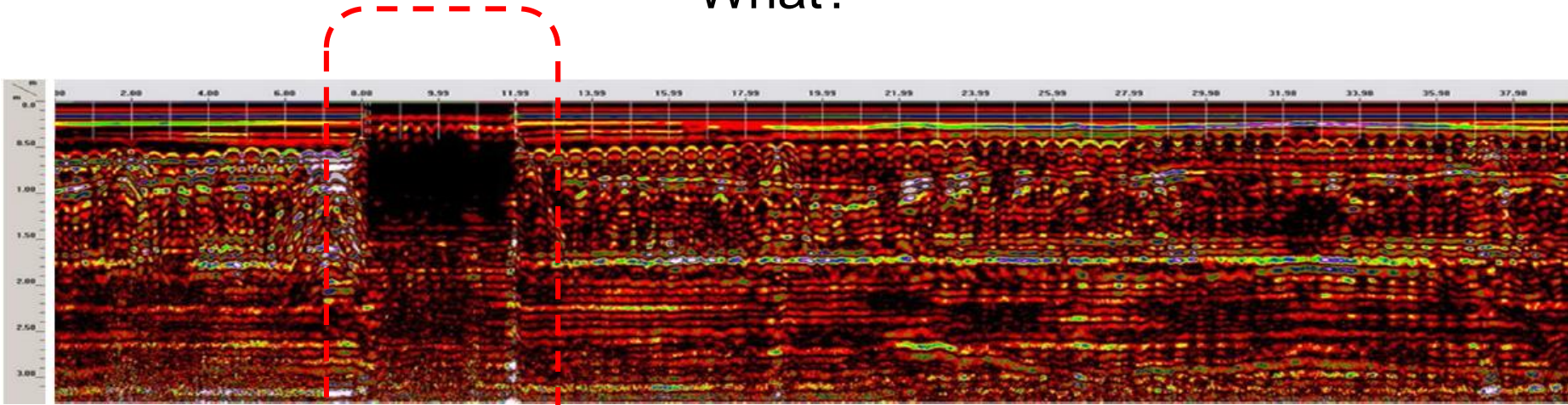


The GPR has one significant advantage.



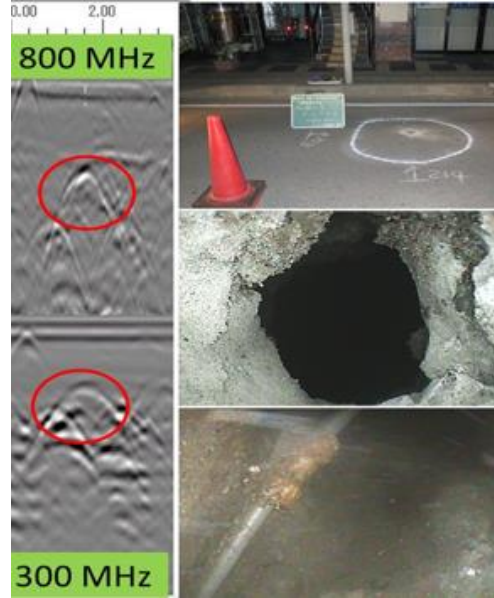
**No matter how hard you look,
nobody understands a damn thing.**

Ground Penetration Radar (GPR)



What?

Where on earth?



- **Vehicle Type: 3D-Ground Penetration Radar (GPR), up to 80 km/h**
- **AI Detection for Cavitation and Utilities**
- **Depth up to 2 m, 10x10 cm cavity detected**
- **Accuracy up to 90%**
- **GIS based Display**



- Vehicle - equipped sensors inspect roads without lane closure or traffic disturbance
- Vehicle - equipped sensors inspect entire road length rather than spot measurement
- AI / Cloud computing reduce human error and human judgement
- However, use with caution and proper conditions



Thank
You