HKCTC & HKAS Webinar on Latest Technology and Development in Building Inspection

(24 Feb 2022)

The Use of Artificial Intelligence (AI) and Drone to Assist Building Inspection for External Wall and Chinese Tiled Roof

應用人工智能技術及無人機輔助政府建築物外牆及中式瓦頂檢測

建築署
Architectural Services Department

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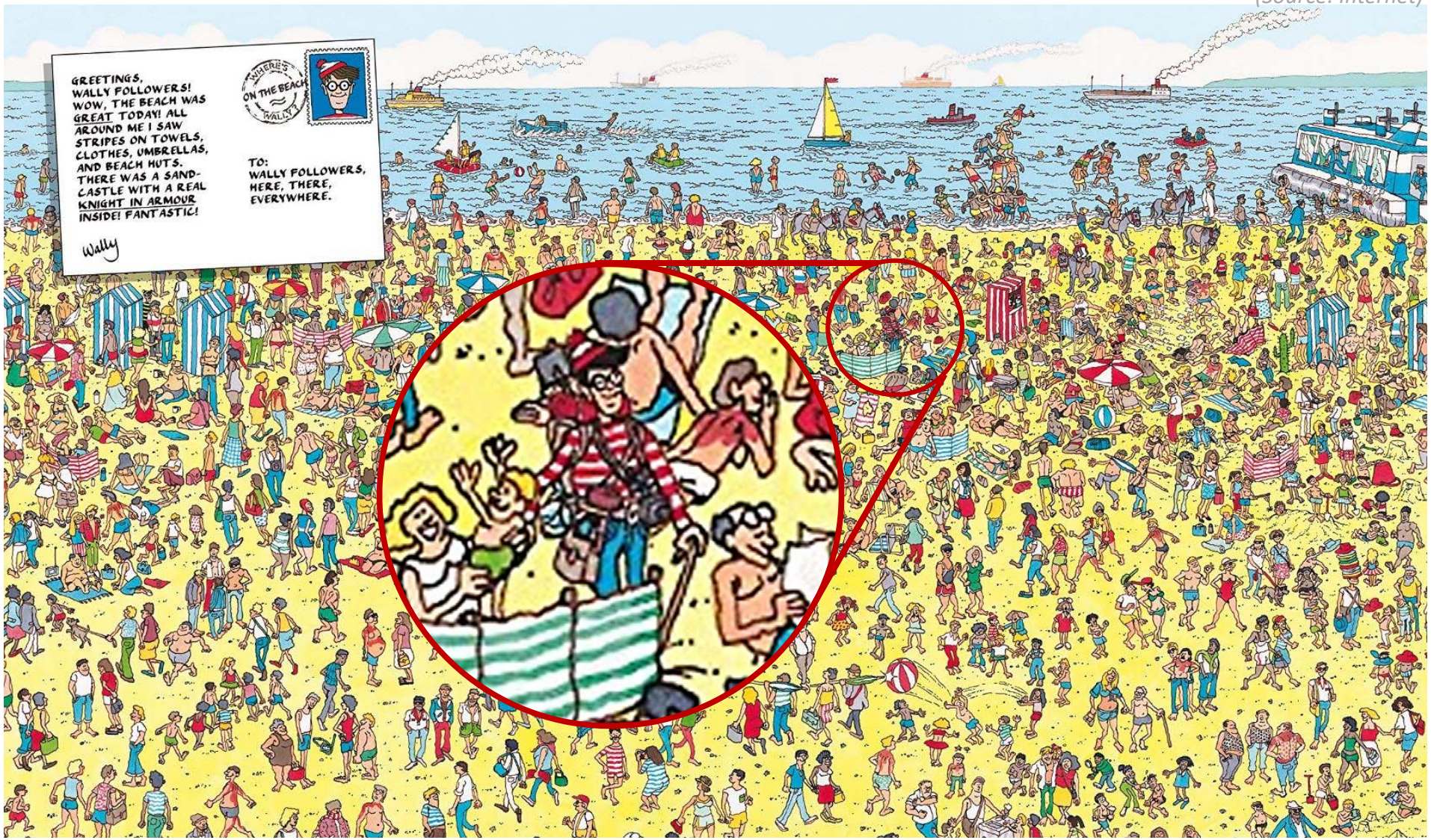
Member of ArchSD Innovative Construction Focus Group

1. EXTERNAL WALL INSPECTION

WHERE'S WALLY?

(Source: Internet)



WHERE'S CRACK?

Cracks on concrete

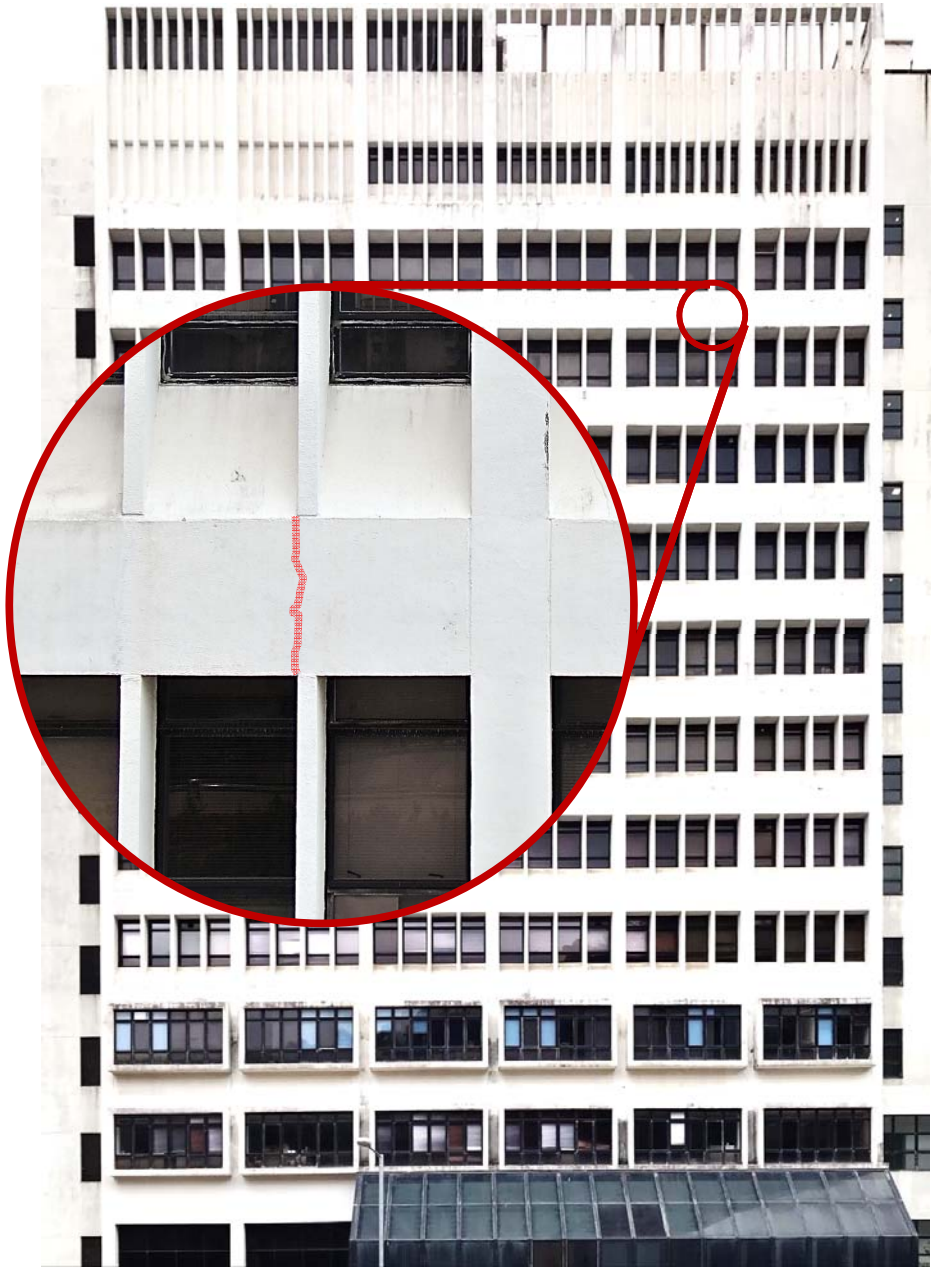
Cracks on tiles

Cracks on plaster

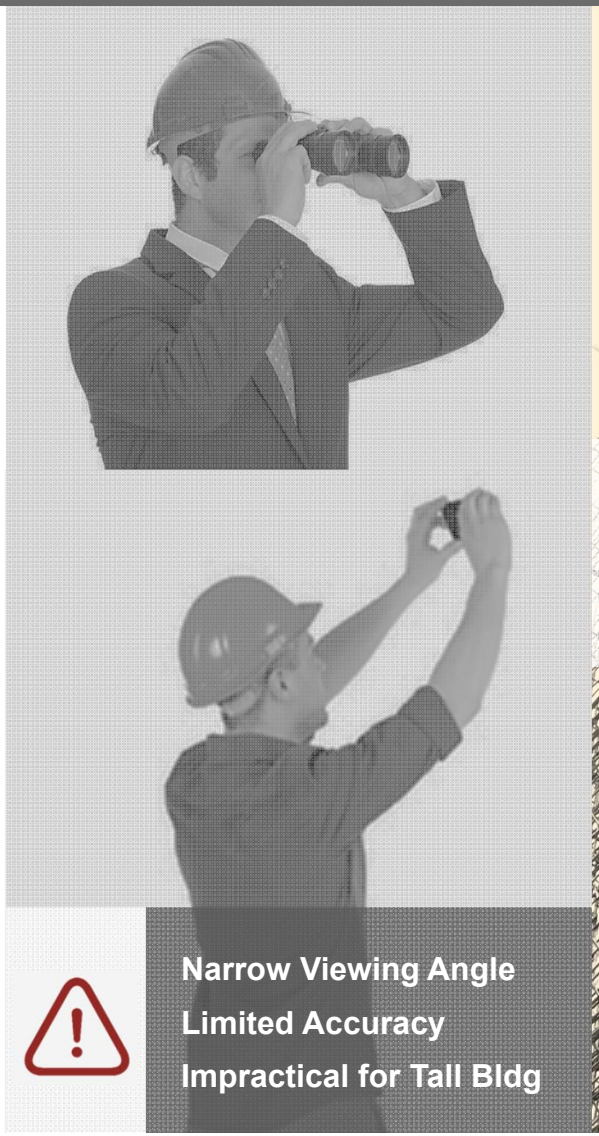
Cracks on paint

HOW ABOUT OTHER DEFECTS?

HOW TO INSPECT?



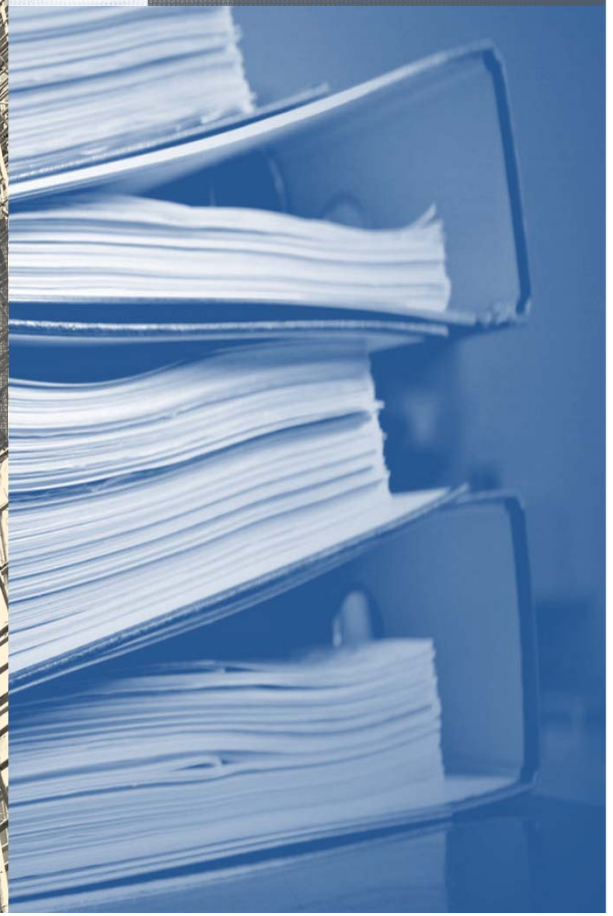
TRADITIONAL APPROACH



Narrow Viewing Angle
Limited Accuracy
Impractical for Tall Bldg

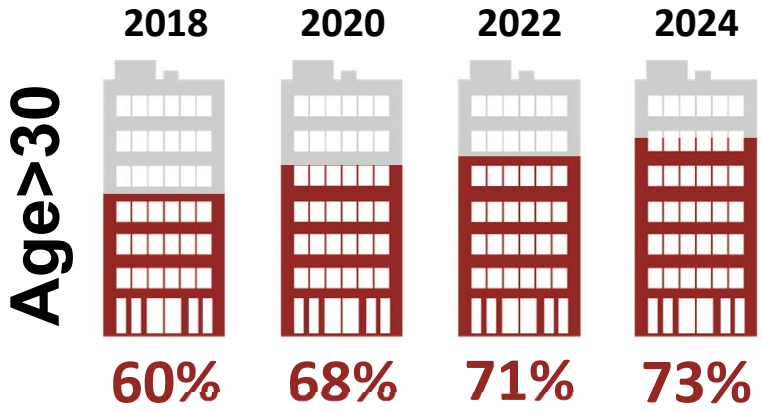
Expensive
Safety Risk
Disturbance to Users

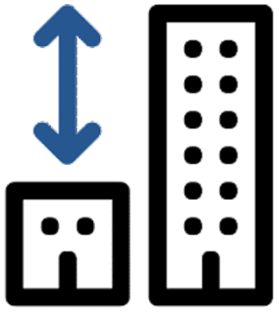
Tedious Data Processing and Reporting
Time-consuming



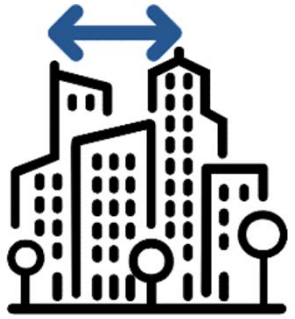
CHALLENGE

> 8,000 Buildings & Facilities under ArchSD's Maintenance

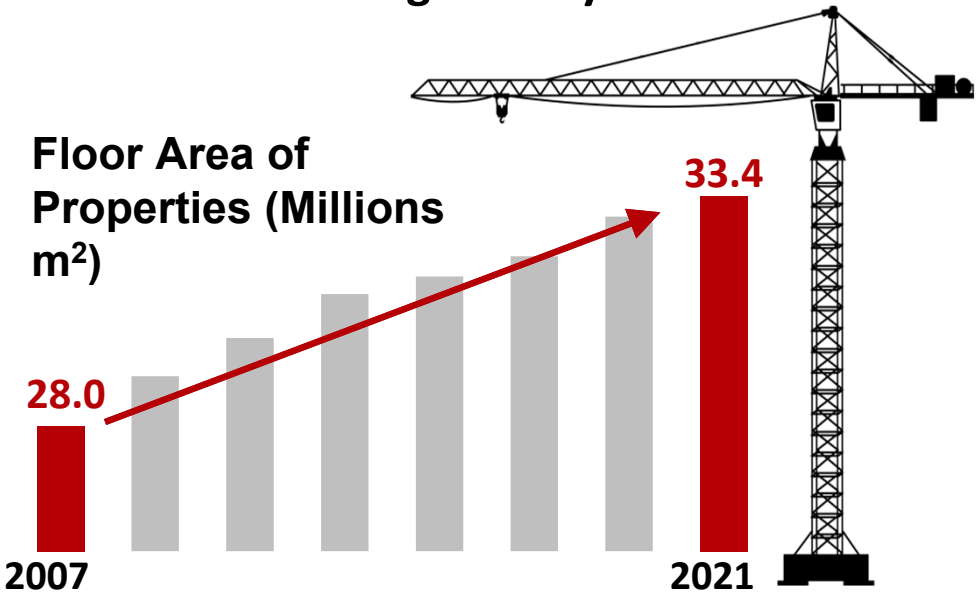




Building Height



Building Density



POLICY DIRECTION

Construction 2.0 *Time to change*

Pillar 1: Innovation

The vision: The development of an Industry culture that embraces change, innovation and new technologies to drive forward productivity, efficiency and enhanced project delivery outcomes.

Pillar 2: Professionalisation

The vision: Improved professionalism of the Industry through step change increases in project leadership, project management, procurement capabilities and professional skills and practices within Government and the private sector, to deliver higher quality construction and built assets, combined with a first priority focus on safety, construction supervision and quality in the workplace.

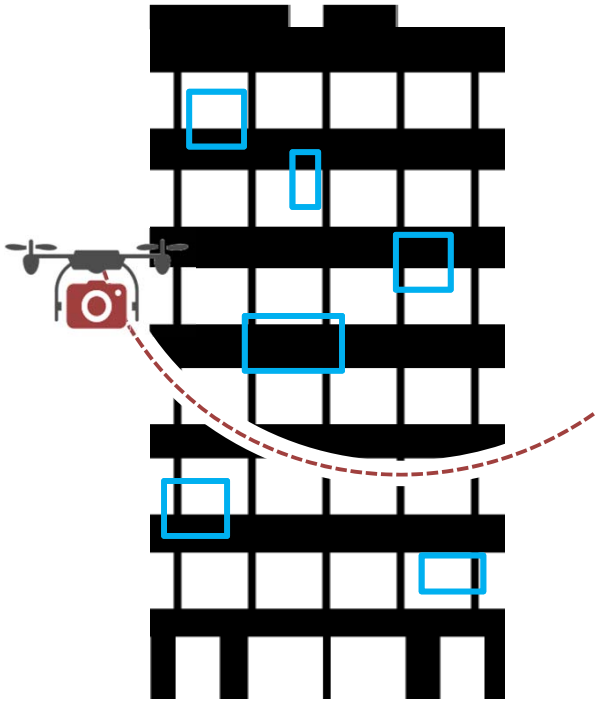
Pillar 3: Revitalisation

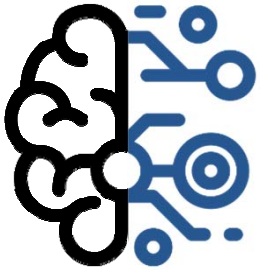
The vision: Reinvigorating the appeal and benefits of joining the Industry to attract and nurture growing numbers of young and energetic talent to the workforce and increasing the agility at the individual, organisational and Industry levels.

發展局
Development Bureau

SOLUTION

Drones with Visual & Thermographic Camera





Artificial Intelligence

External Wall Inspection by Drone

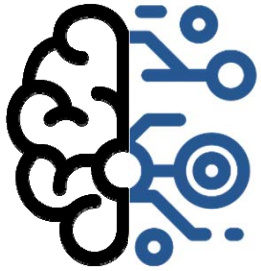
Defects Identification by AI

TECHNOLOGY

Drones with Visual
& Thermographic Camera

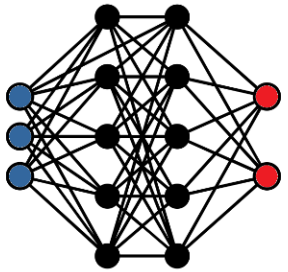
Real Time Kinematics
Positioning

Photogrammetric
Modeling



Artificial Intelligence

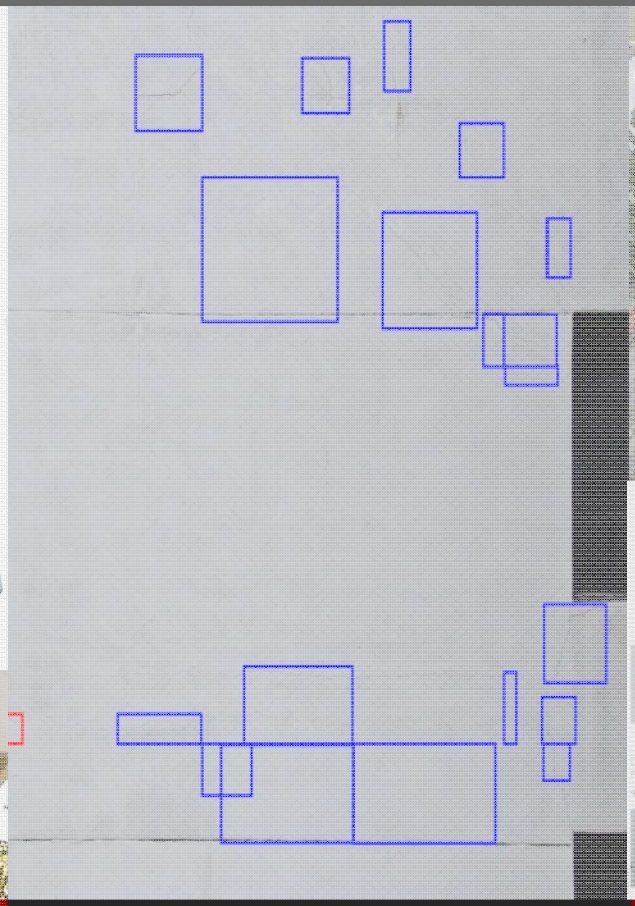
Computer Vision



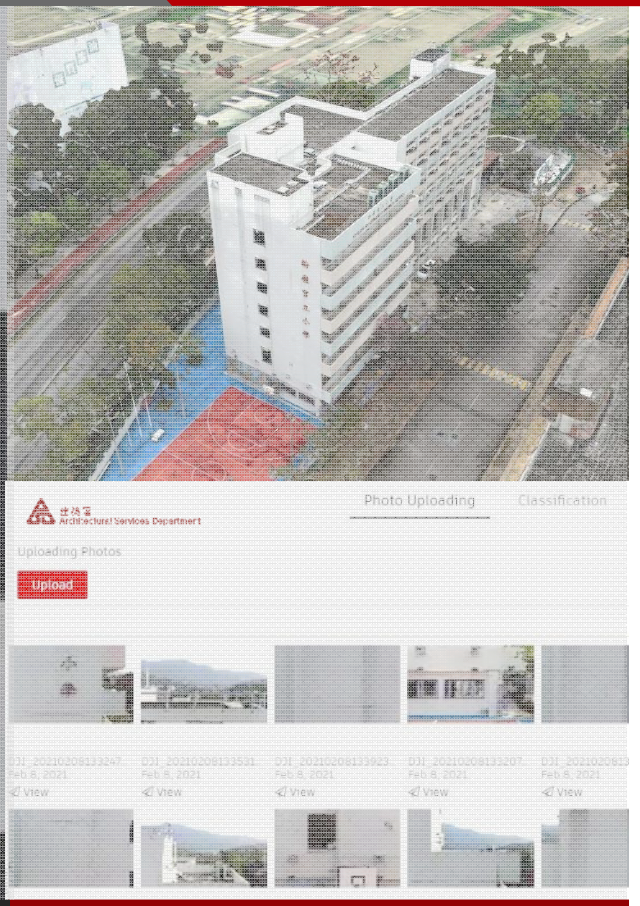
Deep Learning

IMPLEMENTATION

DRONE INSPECTION



AI DEFECT ANALYTICS



VISUALISATION

IMPLEMENTATION

DRONE INSPECTION

EQUIPMENT

- M300 RTK - Stability
- Mavic 2 Enterprise - Agility
- RTK Positioning (±1-3cm)
- H20T Hybrid Camera
  - Visible Light Images (20 MP)
  - Thermogram (640x512)

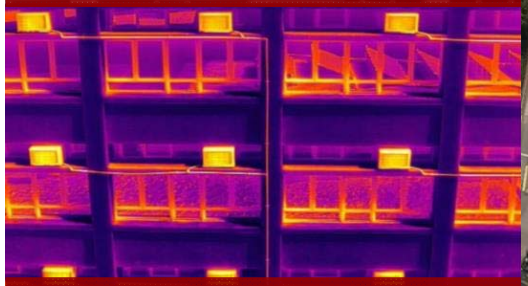
OPERATION

- Designated flight path
- Certified pilot
- Flight Permit by CAD
  - Operations Manual, Flight Plan, Client Permission, Insurance
  - At least 28 working days
- Small Unmanned Aircraft Order will become effective on 1 June 22

TARGET BUILDINGS

- 15 buildings
- Various types & finishes

Visible Light Images

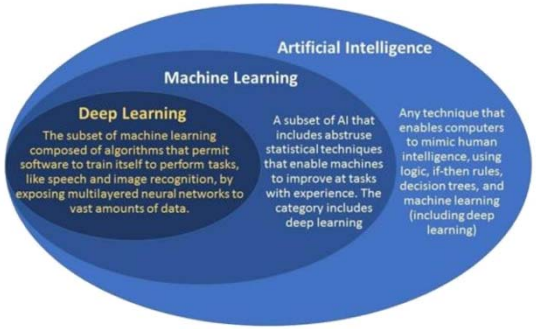


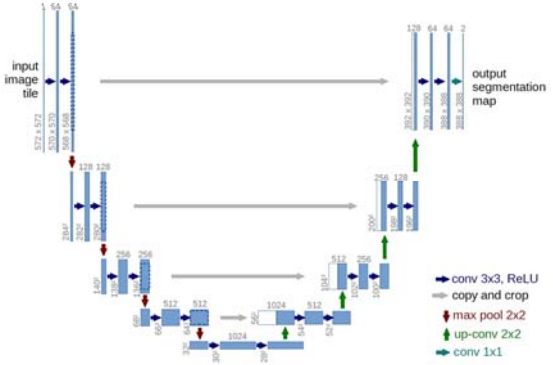
Thermogram

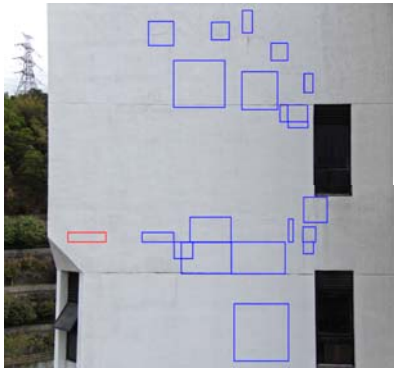
AI DEFECT ANALYTICS

DEPLOYMENT

- Artificial Intelligence → Machine Learning → Deep Learning
- Dataset with defects tagging
- Convolutional Neural Network (U-Net & High-Res Network)
- Automated identification of external wall defects on drone inspection photos



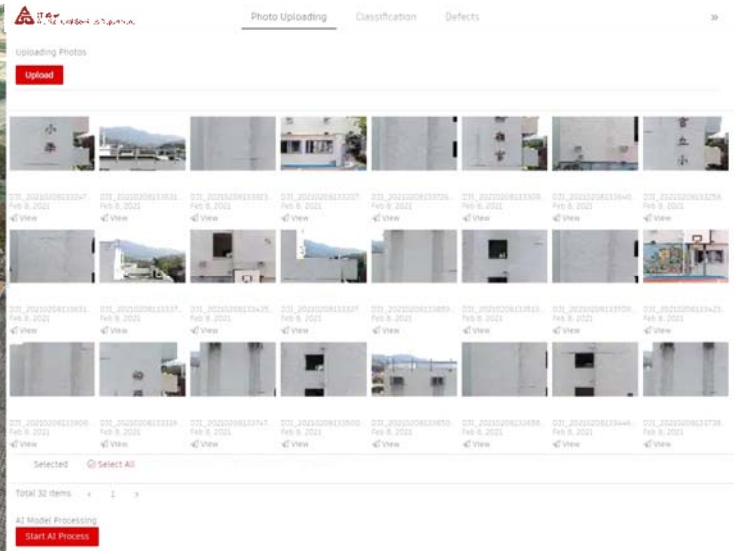




VISUALISATION

DEFECTS REPORTING

- Web-based cloud platform accessible anytime anywhere
- Centralized representation of inspection and defect photos
- Generation of inspection reports



PHOTOGRAMMETRY

- Automated generation of high-resolution 3D mesh models
- Intuitive navigation
- Direct & true-scale measurement of length, area, volume

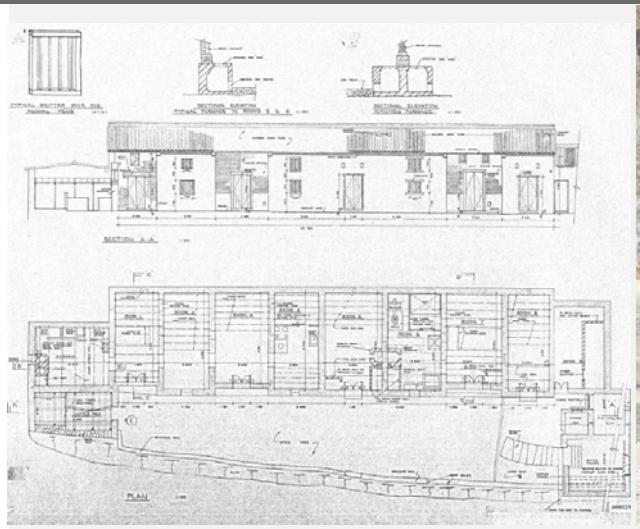
2. CHINESE TILED ROOF INSPECTION

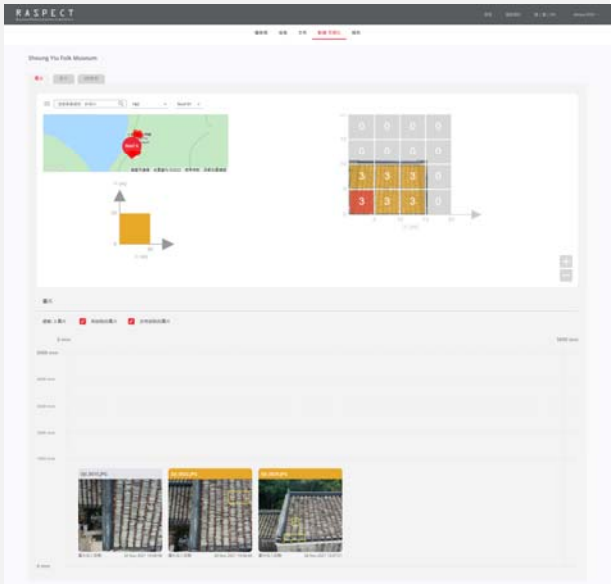
TRADITIONAL APPROACH

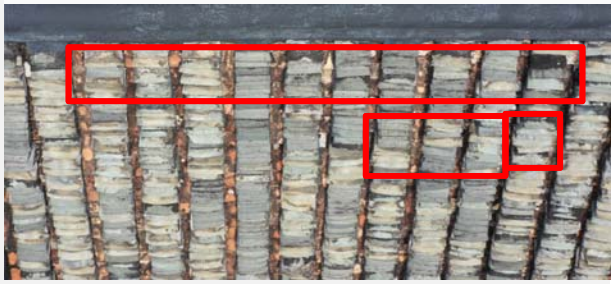
- Expensive
- Safety Risk
- Disturbance to Users

- Narrow Viewing Angle
- Limited Accuracy
- Impractical for Rural Area

IMPLEMENTATION







DRONE INSPECTION

AI DEFECT ANALYTICS

VISUALISATION

IMPLEMENTATION

DRONE INSPECTION

BUILDING ELEMENTS

Main Ridge
Gable Ridge
Cap Tiles / Eave
Roll Tiles
Pan Tiles

DEFECTS

Deformation / Sagging
Missing / Cracked / Displaced Tiles
Cracked Ridge
Vegetation
Insufficient / Excessive Lapping

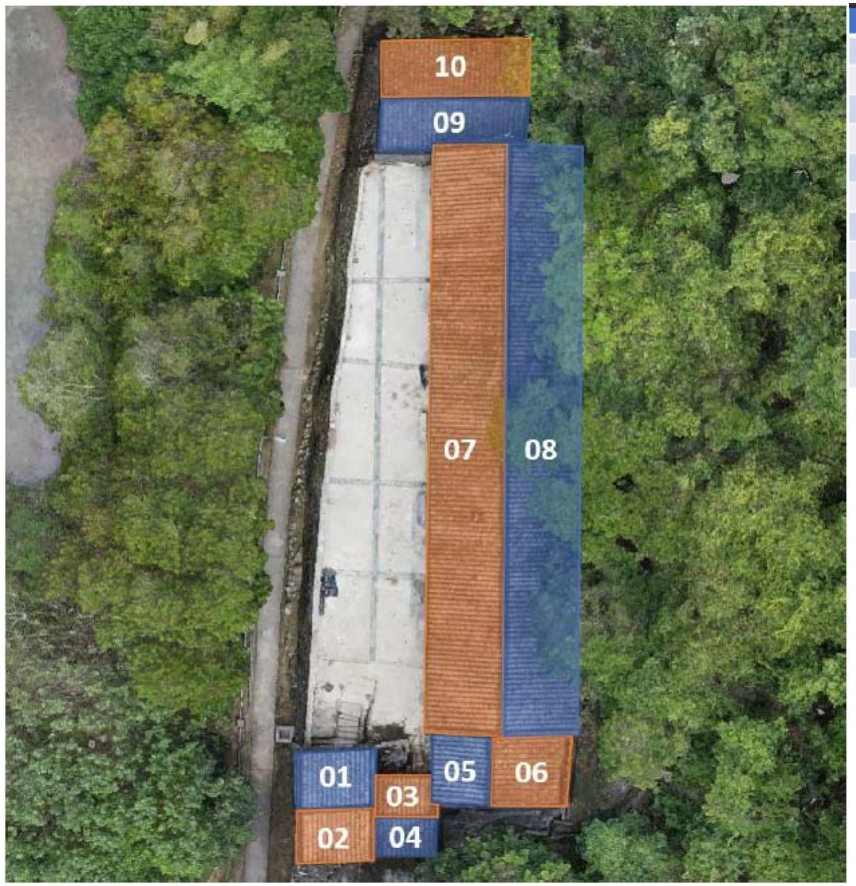
DRONE INSPECTION

EQUIPMENT

- M210 RTK - Stability
- DJI Mavic 2 Pro - Agility
- Zenmuse X5S - Visible Light Images (20 MP)
- Olympus M-ZUIKO 45mm F1.8 Prime Len

TARGET BUILDINGS

- 4 declared monument / historic buildings with Chinese tiled roof under ArchSD's maintenance



PATH	FACE	CAMERA ANGLE
H01	01	Top
H02	01	Top (close-up upper)
H03	01	Top (close-up lower)
H04	01	Perpendicular (upper)
H05	01	Perpendicular (lower)
H06	01	Horizontal
H07	02	Top
H08	02	Top (close-up upper)
H09	02	Top (close-up lower)
H10	02	Perpendicular (upper)
H11	02	Perpendicular (lower)
H12	02	Horizontal

Remarks:
Drone heading always pointing to the roof ridge(屋脊).

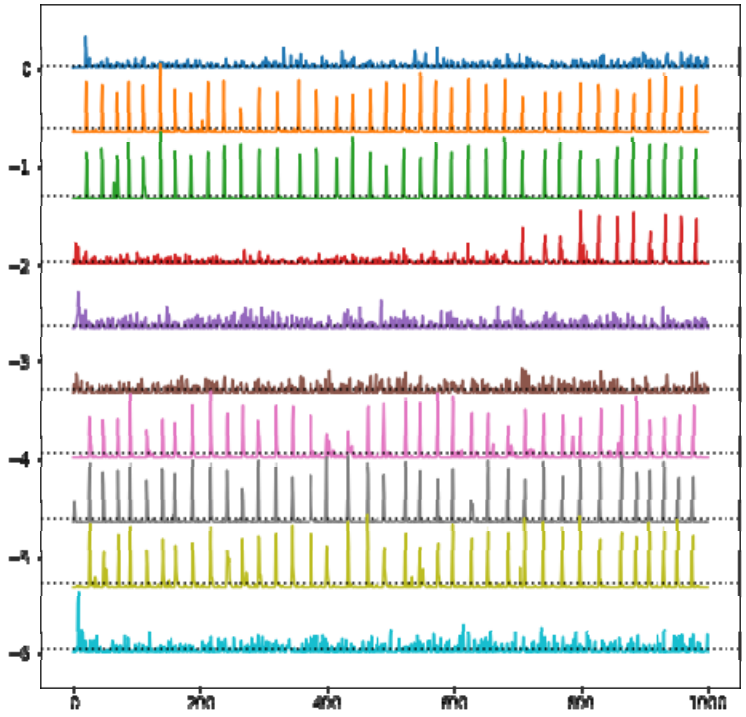
Camera angle legend as below:

1. Top Angle [90 deg]
2. Perpendicular [70 deg]
3. Horizontal [25 deg]

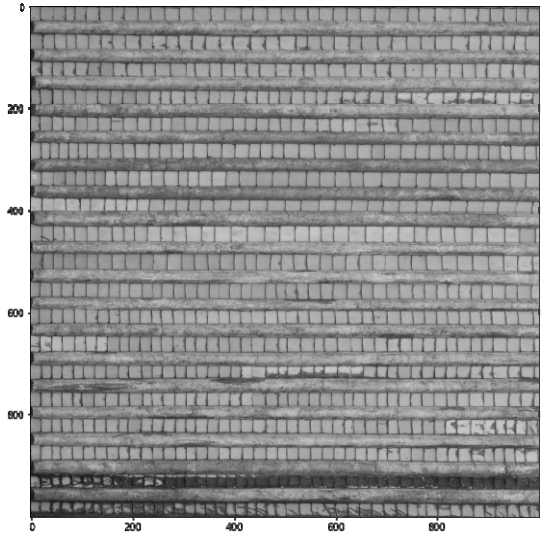
AI DEFECT ANALYTICS

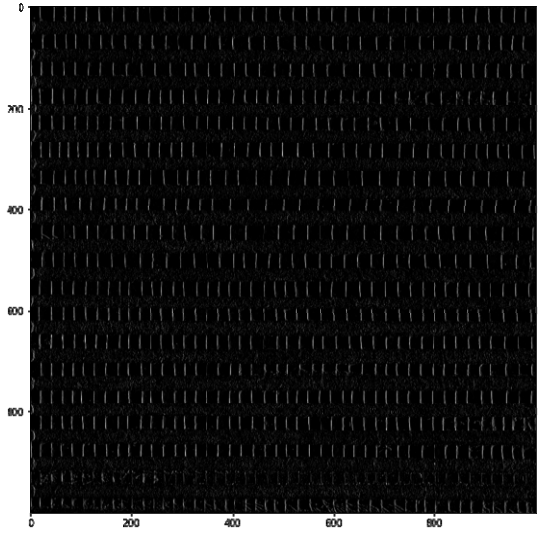
CHECKING OF LAPPING SUFFICIENCY

- Identify tiles column
- Denoise to extract and classify tiles signal
- Signal counting to spot anomalies

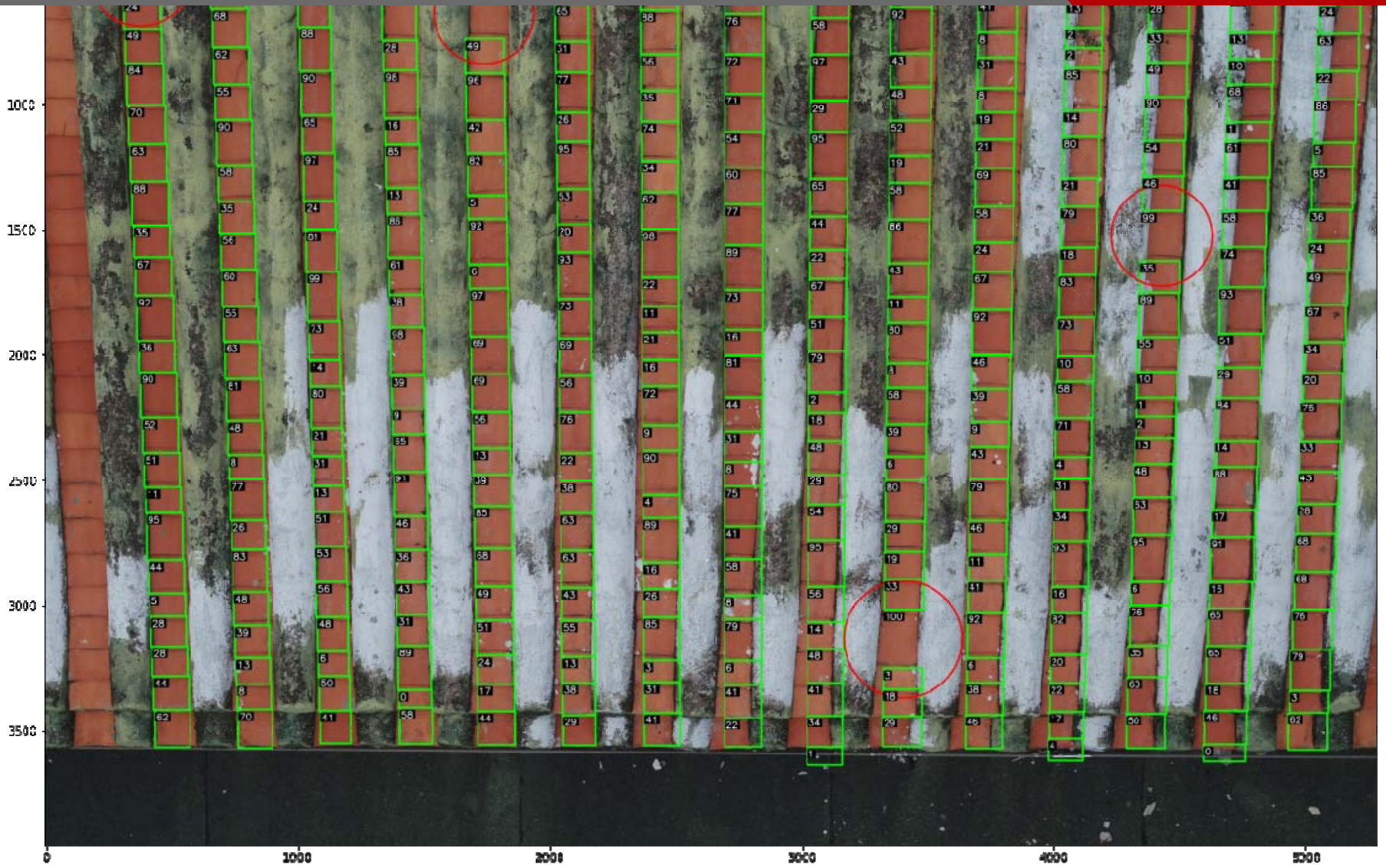


line[0], #of crossings:752
line[10], #of crossings:184
line[20], #of crossings:152
line[30], #of crossings:576
line[40], #of crossings:796
line[50], #of crossings:728
line[60], #of crossings:252
line[70], #of crossings:164
line[80], #of crossings:204
line[90], #of crossings:780





AI DEFECT ANALYTICS



AI DEFECT ANALYTICS

3. TOGETHER WE INNOVATE

BENEFITS

Improve External Wall Inspection Efficiency

Improve Condition Survey Accuracy

Optimize Resources for Preventive Maintenance

Safeguard Building & Public Safety

FUNDING SOURCES

Departmental Vote

Public Sector Trial Scheme (PSTS)

https://www.itf.gov.hk/en/funding-programmes/facilitating-technology/psts/

TechConnect Block Vote (TCBV)

Innovation and Technology Bureau
TechConnect Block Vote Application Form
(2019 RAE)

B/Ds are advised to make reference to the ***Application Guidelines for TechConnect Block Vote*** in completing this Application Form.

1. General Information

Bureau/Department:	
Project Title:	
(English)	
(Chinese)	
Project Nature:	☐ Technical Study ☐ Pilot/Trial ☐ Implementation
Non-recurrent Cost ($'000):	**Date of Submission (dd-mm-yy):**
Priority of Bid[1]:	
Planned Project Commencement (mm-yy):	**Planned Project Roll-out[2] (mm-yy):** **Planned Project Completion (mm-yy):**

https://data.gov.hk/tc-data/dataset/hk-itb-itb02-techconnect-block-vote

FEATURE VIDEOS

Episode 1

Episode 2

LIVE DEMONSTRATION

THANK YOU

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Architectural Services Department

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