

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

(24 Feb 2022)

A photograph of a drone with a camera attached, flying in front of a light-colored building wall. The drone is positioned in the center of the frame, and the building wall is the background. The text is overlaid on the right side of the image.

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

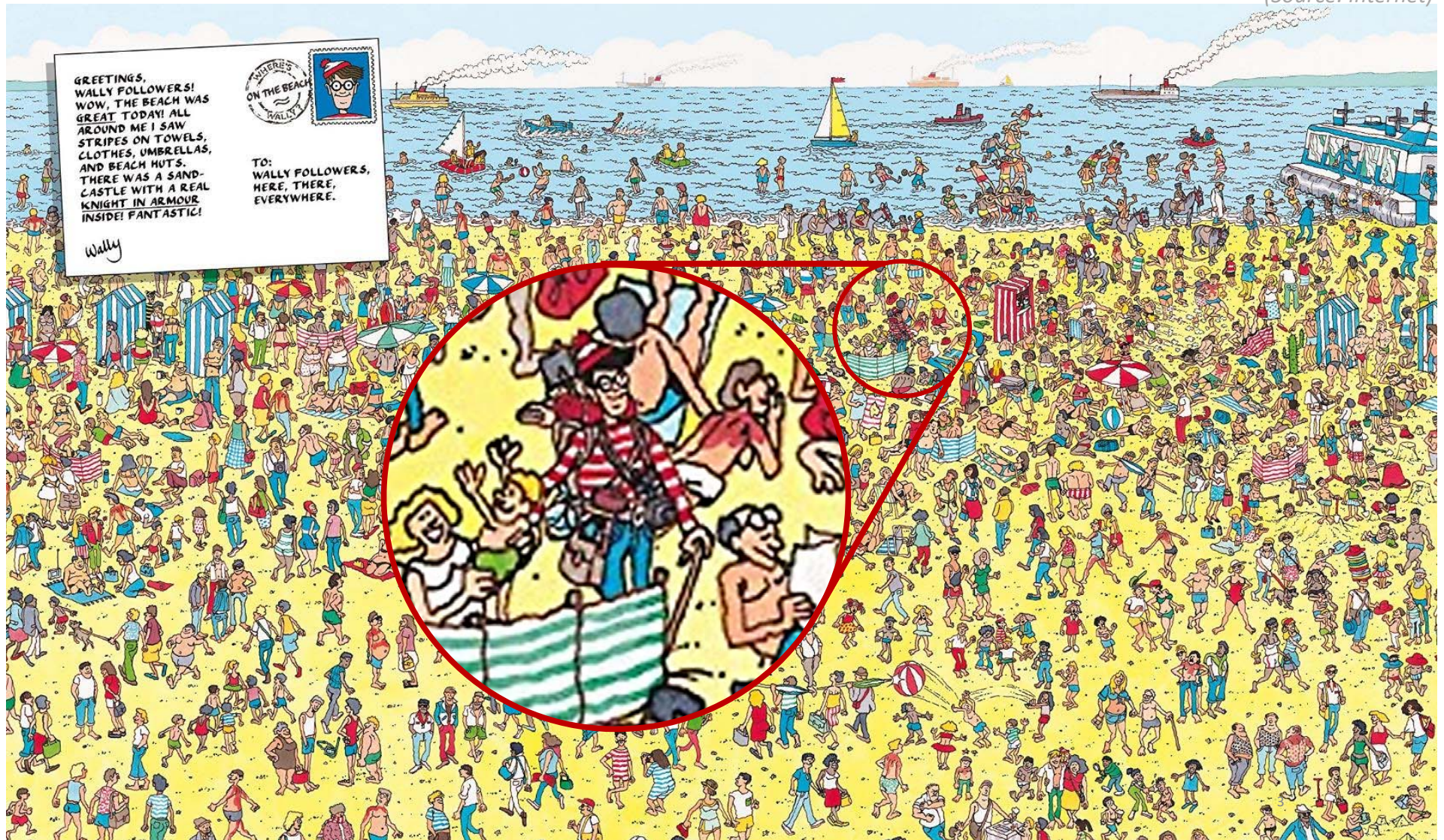
應用人工智能技術及無人機輔助政府建築物外牆及中式瓦頂檢測

A drone is shown in flight, positioned centrally in the upper half of the frame. It is a quadcopter with a camera mounted underneath. The background is a large, curved, light-colored building facade, possibly made of concrete or stone, with several rectangular windows visible along the top edge. The lower half of the image shows a dark, curved surface, likely a roof or a lower part of the building. The overall scene is set against a clear sky.

1. EXTERNAL WALL INSPECTION

WHERE'S WALLY?

(Source: Internet)



WHERE'S CRACK?



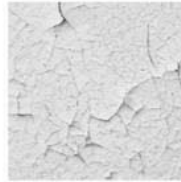
Cracks on
concrete



Cracks on
tiles



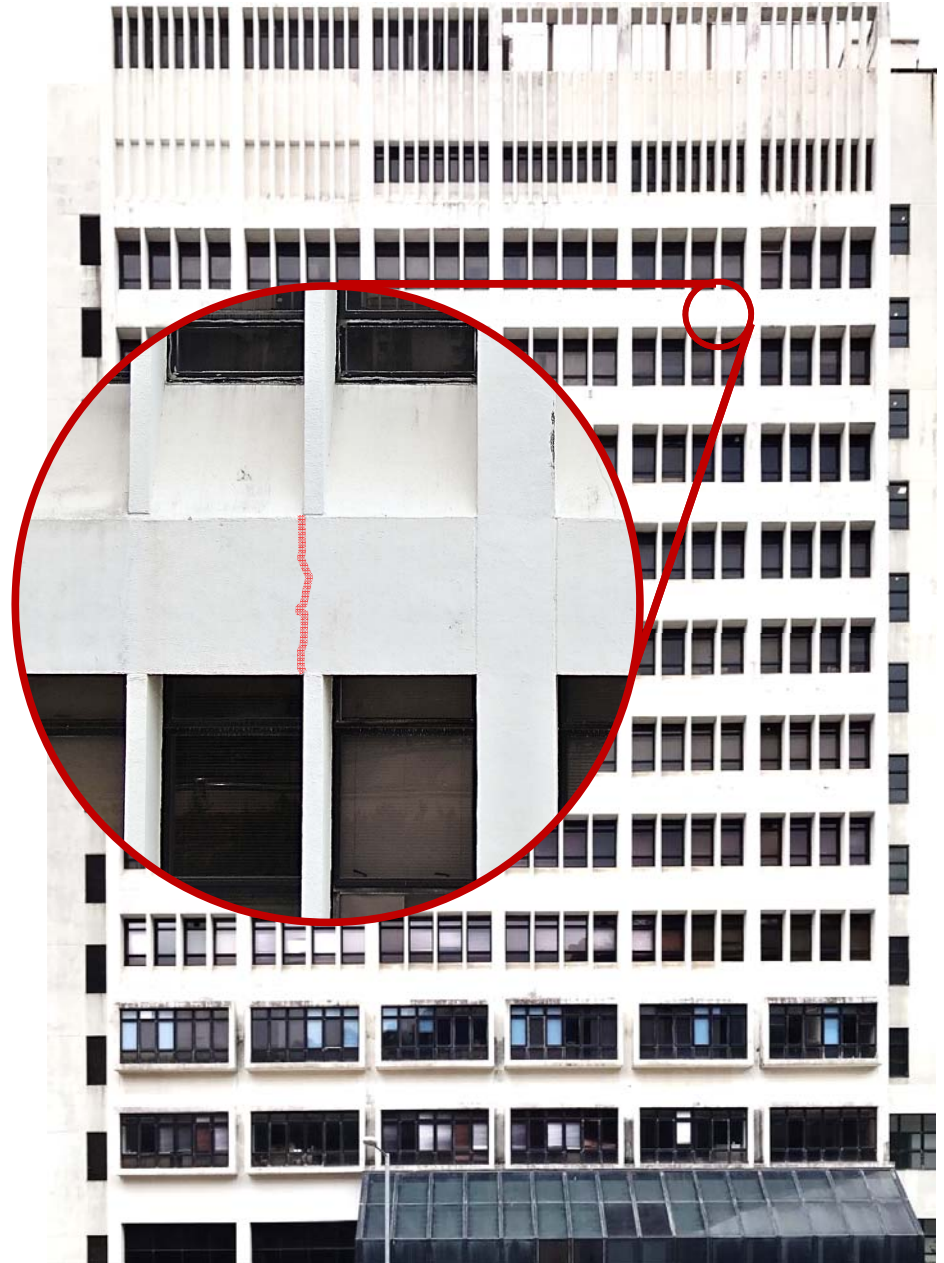
Cracks on
plaster



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**

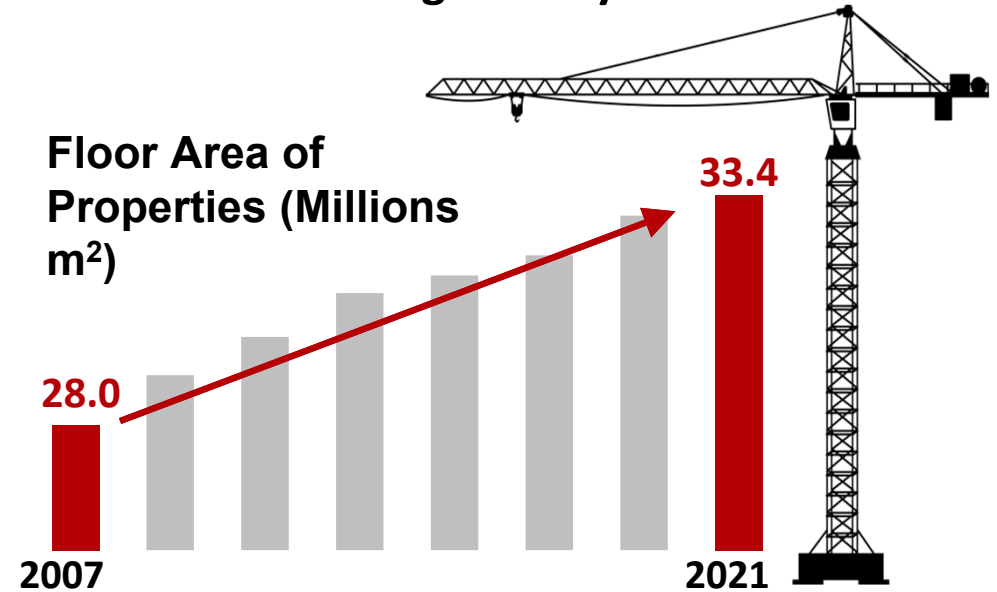
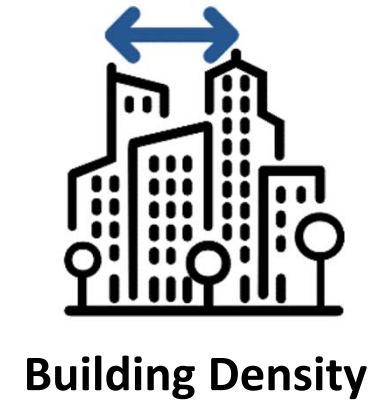
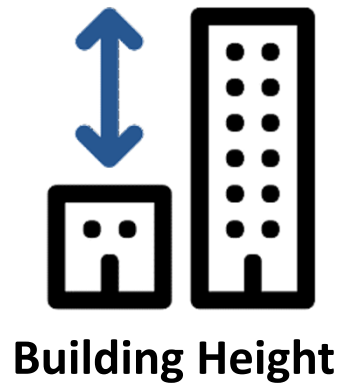
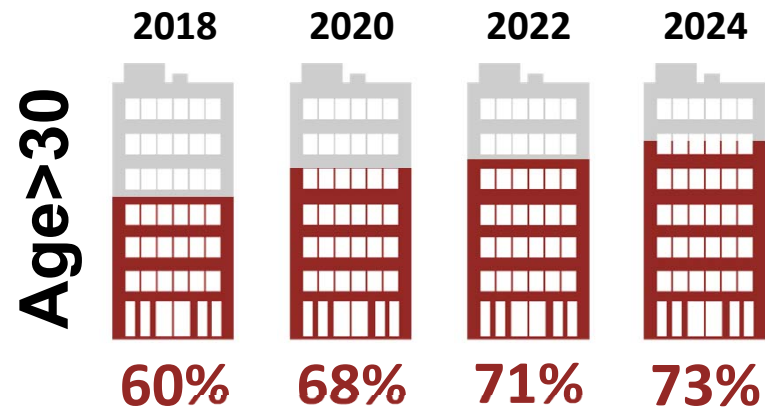


**Tedious Data Processing
and Reporting
Time-consuming**



CHALLENGE

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



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.

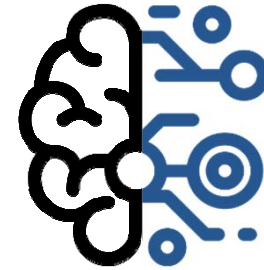
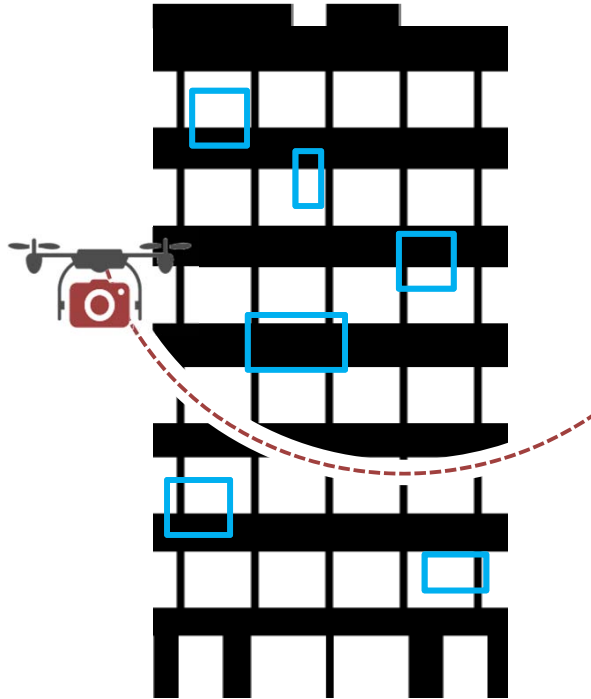


發展局
Development Bureau

SOLUTION



**Drones with Visual
& Thermographic
Camera**



Artificial Intelligence

External Wall Inspection by Drone **Defects Identification by AI**

TECHNOLOGY



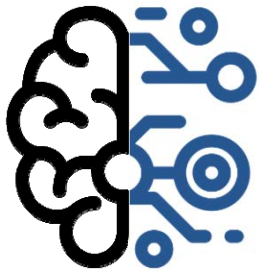
**Drones with Visual
& Thermographic Camera**



**Real Time Kinematics
Positioning**



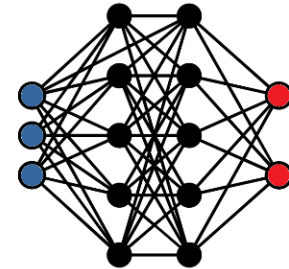
**Photogrammetric
Modeling**



Artificial Intelligence



Computer Vision

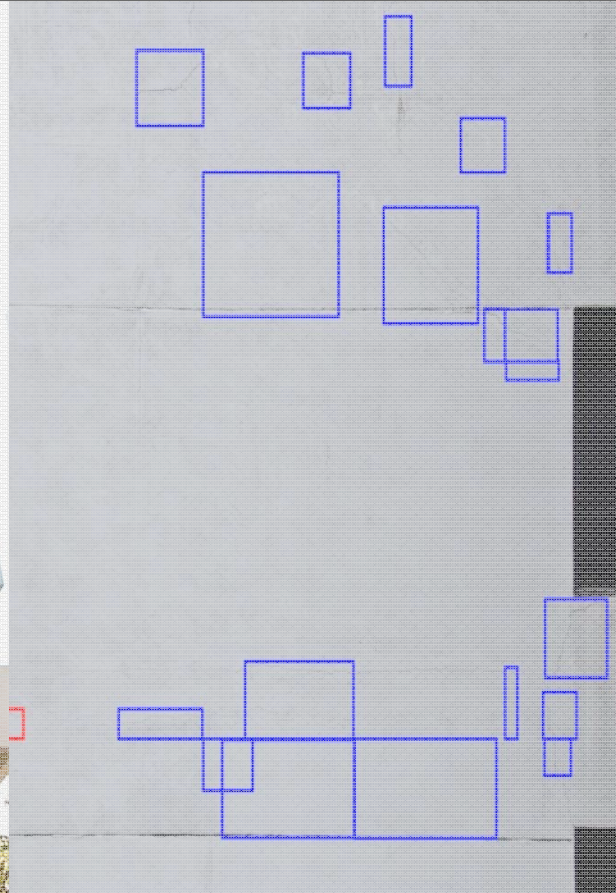


Deep Learning

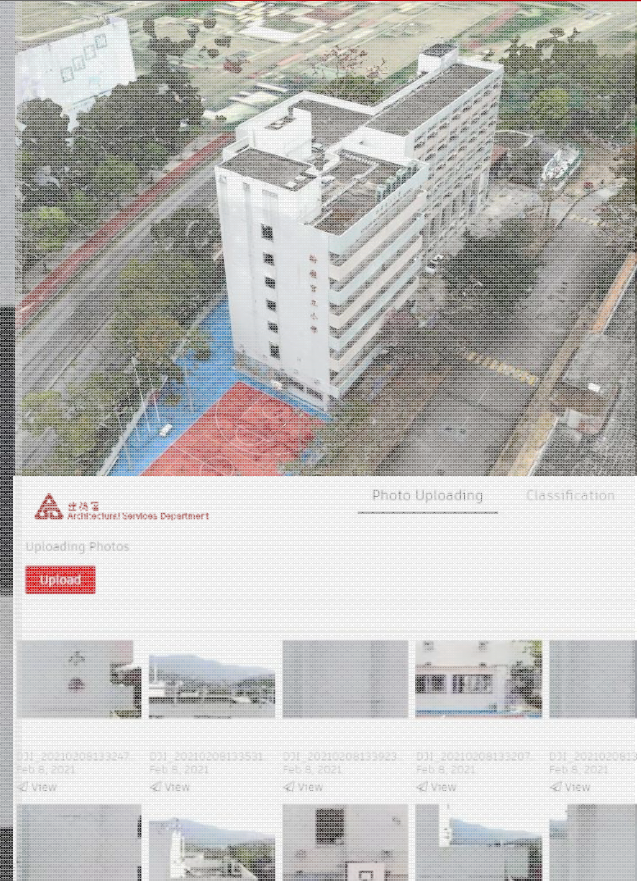
IMPLEMENTATION



**DRONE
INSPECTION**

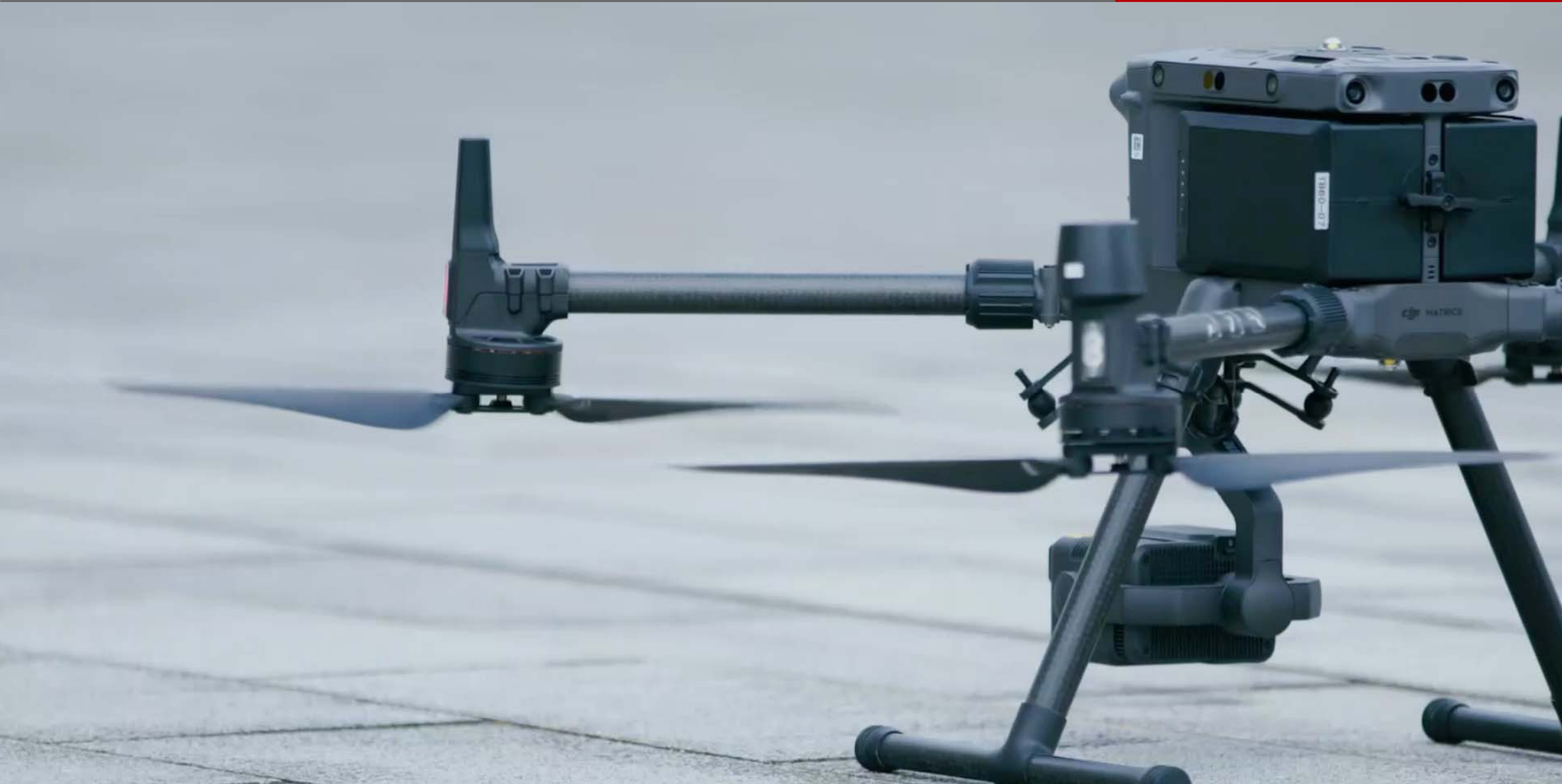


**AI DEFECT
ANALYTICS**



VISUALISATION

IMPLEMENTATION



DRONE INSPECTION

EQUIPMENT

- M300 RTK - Stability
- Mavic 2 Enterprise - Agility
- RTK Positioning ($\pm 1-3\text{cm}$)
- 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

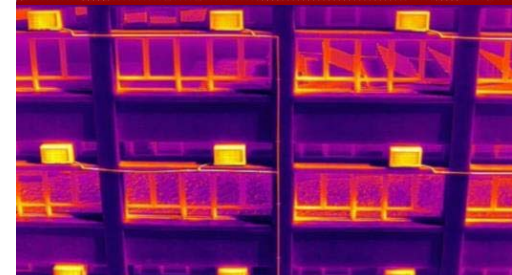


TARGET BUILDINGS

- 15 buildings
- Various types & finishes



Visible Light Images



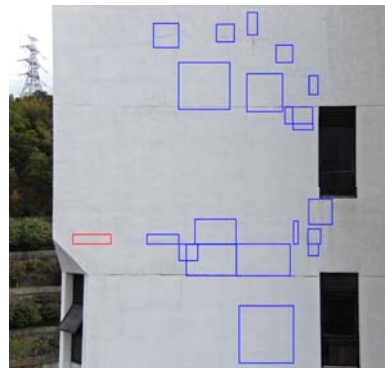
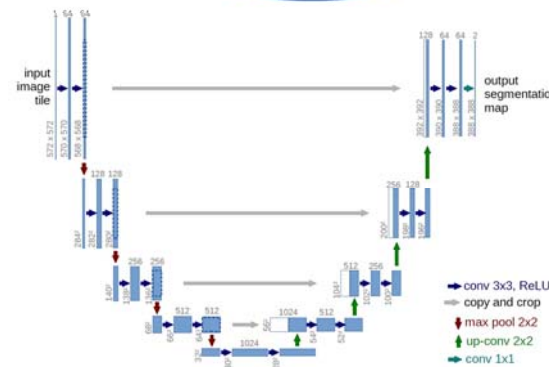
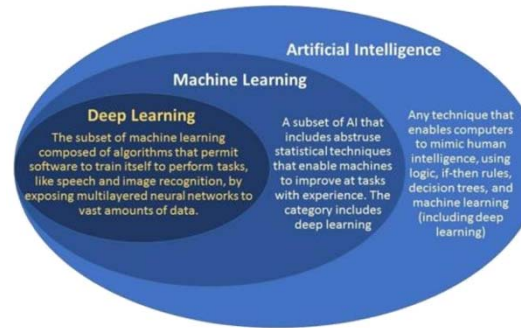
Thermogram



AI DEFECT ANALYTICS

DEPLOYMENT

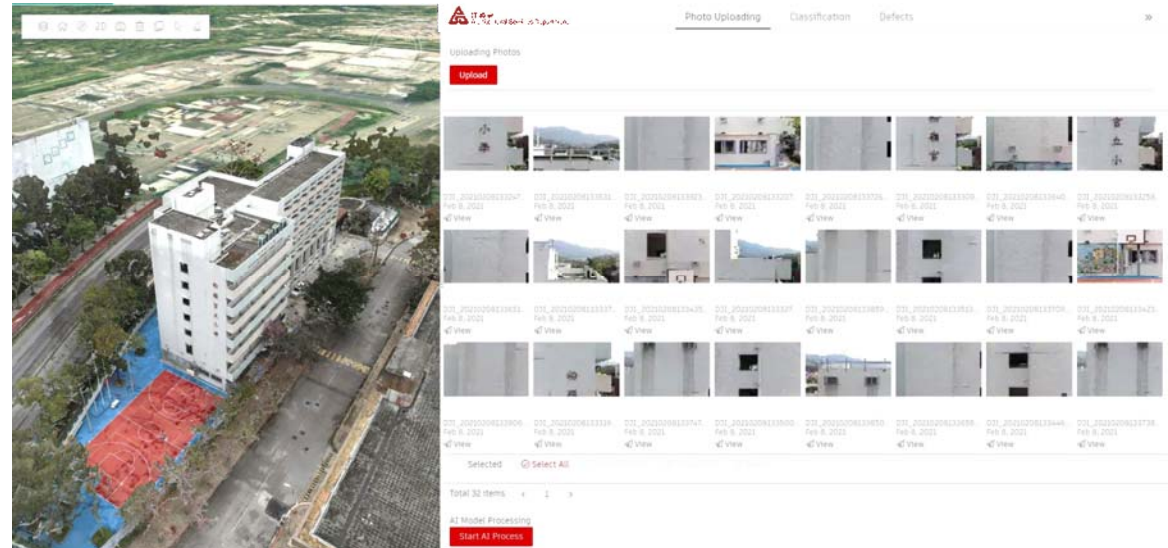
- Artificial Intelligence → Machine Learning → Deep Learning
- Dataset with defects tagging
- Convolutional Neural Network (U-Net & High-Res Network)
- Automated identification of external wall defects on drone inspection photos



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



An aerial photograph showing a dense cluster of traditional Chinese buildings with tiled roofs. The roofs are covered in dark, curved tiles and feature ornate, upturned eaves. The perspective is from a high angle, looking down on the rooftops. The text "2. CHINESE TILED ROOF INSPECTION" is overlaid in the center in a bold, blue, sans-serif font.

2. CHINESE TILED ROOF INSPECTION

TRADITIONAL APPROACH

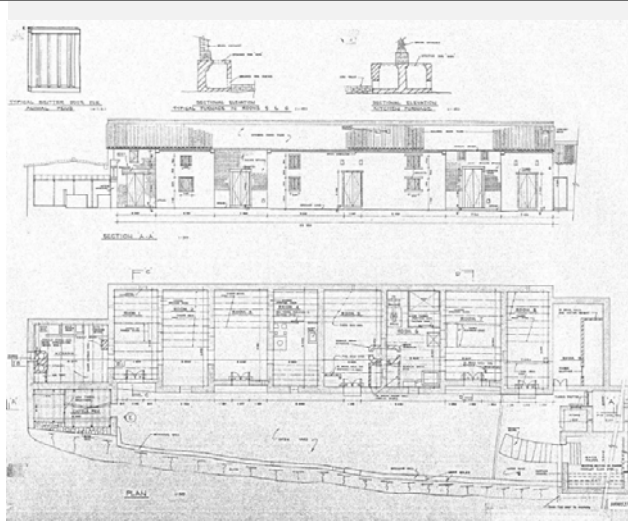


**Expensive
Safety Risk
Disturbance to Users**



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

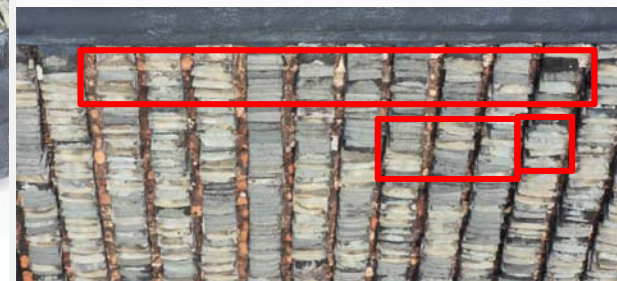
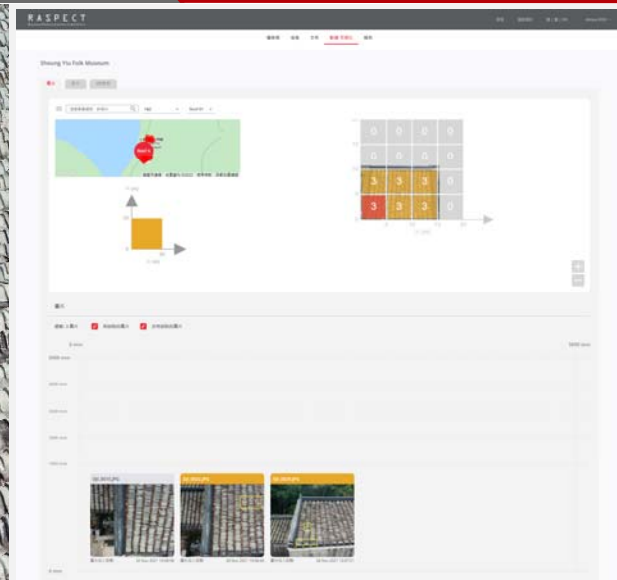
IMPLEMENTATION



**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:

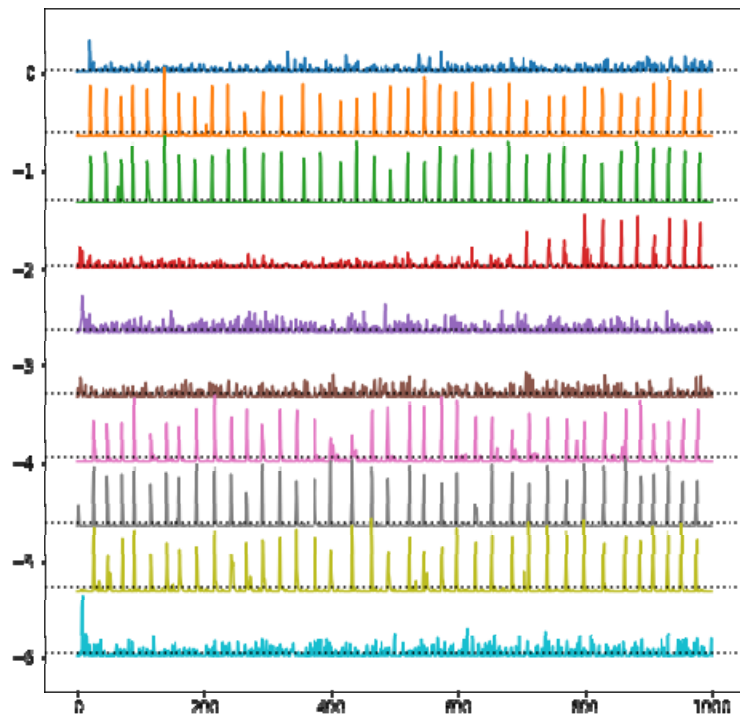


1. Top Angle [90 deg]
2. Perpendicular [70 deg]
3. Horizontal [25 deg]

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

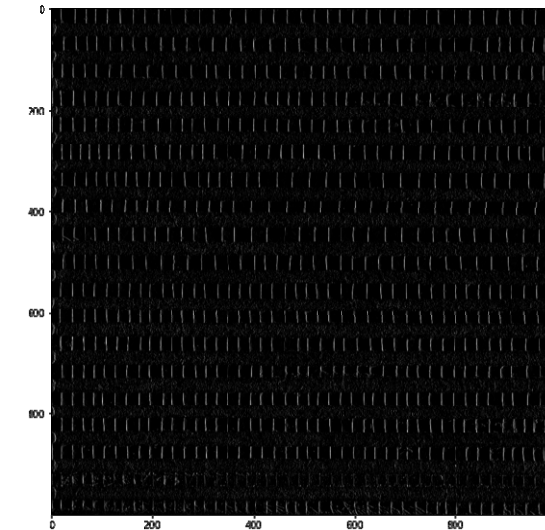
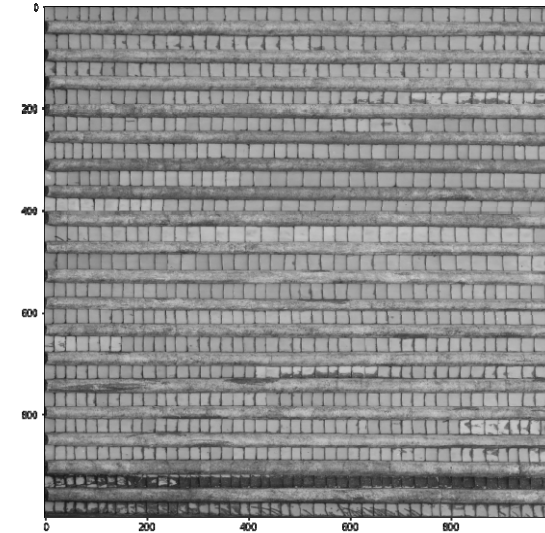
line[50], #of crossings:728

line[60], #of crossings:252

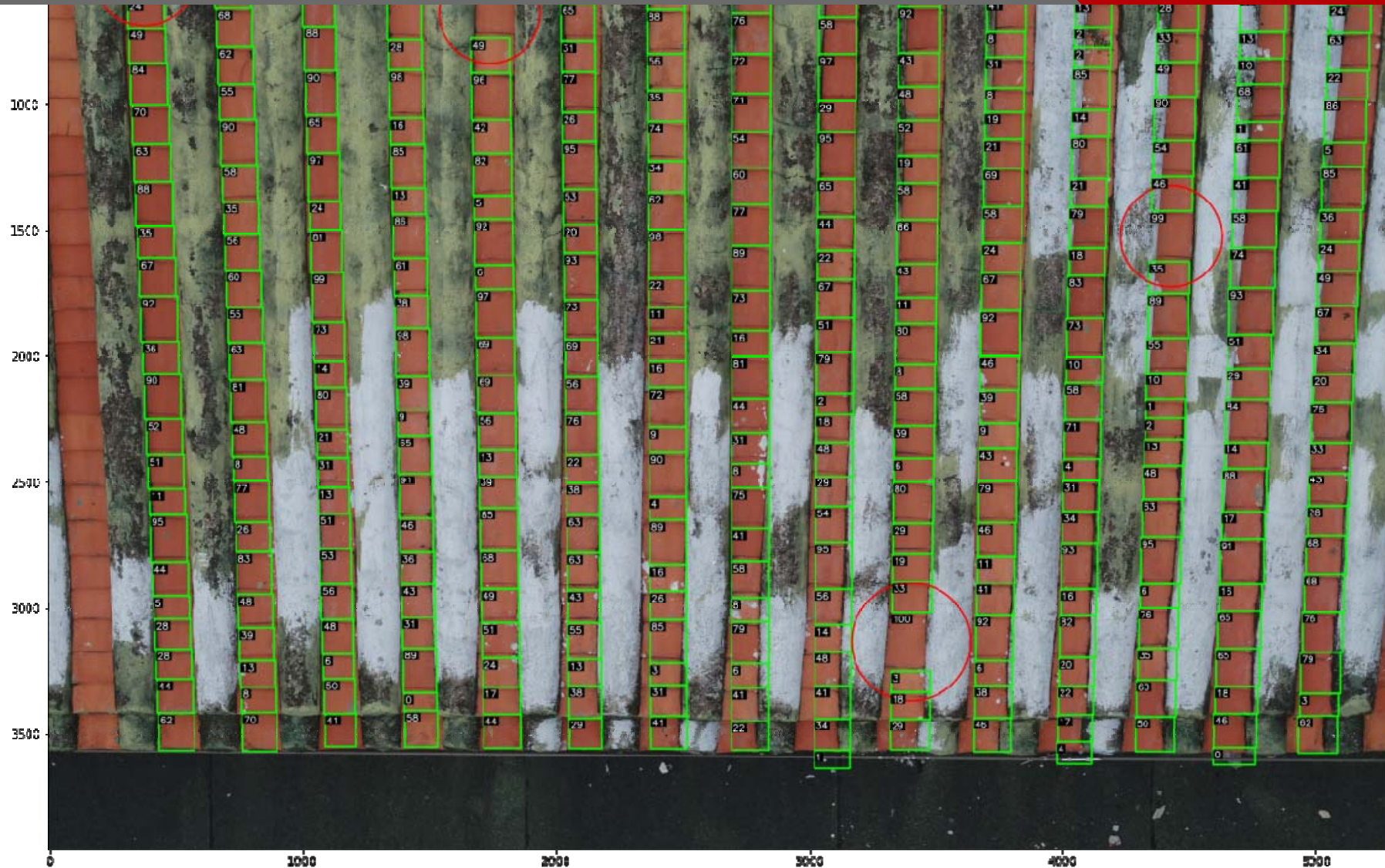
line[70], #of crossings:164

line[80], #of crossings:204

line[90], #of crossings:780



AI DEFECT ANALYTICS



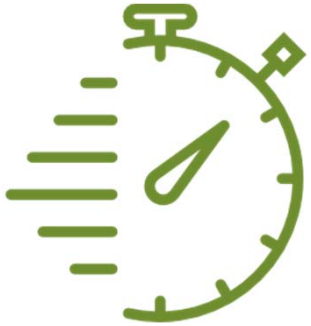
AI DEFECT ANALYTICS



An aerial, high-angle photograph of a dense cluster of traditional Chinese buildings. The most prominent feature is the intricate pattern of dark, curved tiled roofs, which are layered and overlapping, creating a complex geometric design. The roofs have a characteristic 'wavy' or 'undulating' appearance. The buildings are tightly packed together, with very little open space visible between them. The overall tone of the image is somewhat muted, with a focus on the textures and patterns of the architecture.

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)



Public Sector Trial Scheme (PSTS-ITF)

- For realisation and commercialisation of R&D results under ITF projects



Public Sector Trial Scheme for Incubatees & Graduate Tenants of Hong Kong Science & Technology Parks Corporation and Hong Kong Cyberport Management Company Limited (PSTS-SPC)

- For realisation and commercialisation of R&D results developed by incubatees or graduate tenants of HKSTPC or Cyberport



**Innovation and Technology Fund
Innovation and Technology Commission**
The Government of the Hong Kong Special Administrative Region



Public Sector Trial Scheme for Technology Companies (PSTS-TC)

- For realisation and commercialisation of R&D results developed by technology companies outside HKSTPC and Cyberport conducting R&D activities in Hong Kong

<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:	<input type="checkbox"/> Technical Study	<input type="checkbox"/> Pilot/Trial	<input type="checkbox"/> Implementation
Non-recurrent Cost (\$'000):		Date of Submission (dd-mm-yy):	
Priority of Bid:			
Planned Project Commencement (mm-yy):		Planned Project Roll-out (mm-yy):	Planned Project Completion (mm-yy):

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

FEATURE VIDEOS



樓宇檢測大挑戰

Episode 1



Episode 2



A black and white photograph of a drone flying in front of a large, curved, metallic building facade. The drone is a quadcopter with a camera mounted underneath. The building has a series of rectangular windows or vents along the top edge. The text "LIVE DEMONSTRATION" is overlaid in blue capital letters in the center of the image.

LIVE DEMONSTRATION



THANK YOU