3D RECONSTRUCTION OF WIND TURBINES & COMPUTATIONAL VISUAL INSPECTION

Aqua Forge Robotics Pvt Ltd

U85500TN2024PTC174533

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Why wind turbine inspection is necessary?

Wind turbine components are subjected to a variety of **harsh conditions daily, including hail, snow, lightning, rain, salt, and dust**. On top of these environmental stresses, **turbine blades can also sustain damage** from factors like extreme load-induced **buckling or manufacturing defects** that result in debonding. During routine wind turbine inspections, some common defects typically found in different parts include

- **Tower:** Cracks, damage, peeling paint, corrosion
- **Blade:** Cracks, damage, peeling paint, deformation, lightning strike marks, water ingress
- **Nacelle:** Lightning strike marks, cracks, damage, corrosion, oil leaks, peeling paint
- **Hub:** Misalignment, loose connections, damage

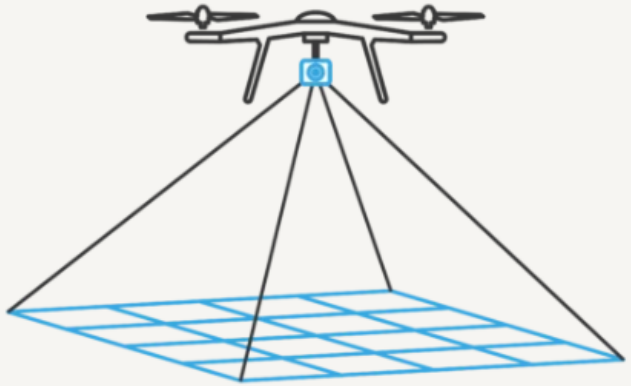
Also can be used for **Digital twin modelling.**

Drone based Inspection & 3D Model of Wind turbines

- **Safety:** Drones eliminate the need for human ascent, drastically reducing the risk and ensuring a safe inspection environment.
- **Data Quality:** The high-resolution imagery and potential for thermographic inspection provide high-quality data, facilitating a thorough assessment.
- **Time:** A stark contrast to traditional methods, drone inspections take between 15 minutes to 1 hour.
- **Efficiency:** The expedited process allows for the inspection of 5+ turbines per day.
- **Labor:** A one-person job, significantly reducing the labor requirement.
- **Cost:** The reduced labor and time result in lower inspection costs.

	Rope Access/ Traditional inspection	Drone inspection
Safety	Hazardous	Safe
Data Quality	High Quality	High Quality
Time	3-6 hours	15min - 1h
Efficiency	1-2 turbines per day	5+ turbines per day
Labor	Minimum 3 people	One-person job
Cost	High	Low

TIME SAVED



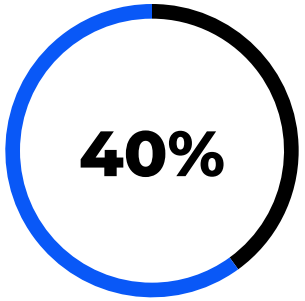
ULTRA HIGH-RESOLUTION

MAJOR COST SAVING

Innovative Features of Drone Inspections

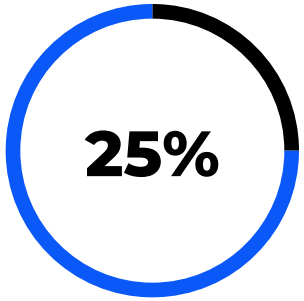
- **Dynamic Surveying** - Drones offer a dynamic surveying capability, capturing hundreds of detailed images from varied angles.
- **Access to Inaccessible Areas** - They can access previously unreachable or dangerous areas, ensuring a comprehensive inspection.
- **High-Quality Data** - Coupled with infrared cameras, drones can discern weaknesses and variations in structure surface temperatures, enabling a non-destructive inspection method.
- **Preventive Maintenance Planning** - The rich data captured aids in preventive maintenance planning, ensuring timely interventions before minor issues escalate into major problems.

FUTURE TRENDS & CHALLENGES



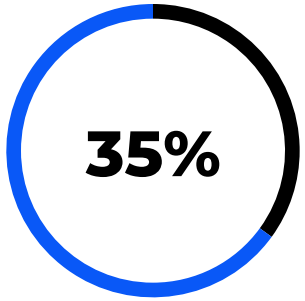
SHIFTING TOWARDS AUTOMATION

Automation is expected to dominate the wind energy sector, influencing inspection processes.



DECREASING IMPLEMENTATION COSTS

As technologies mature, the costs of implementation are expected to decrease, increasing accessibility.



ANALYTICS INTEGRATION

Data analytics will play a critical role in improving decision-making in wind turbine management.

FLOW CHART

Drone Survey

↓

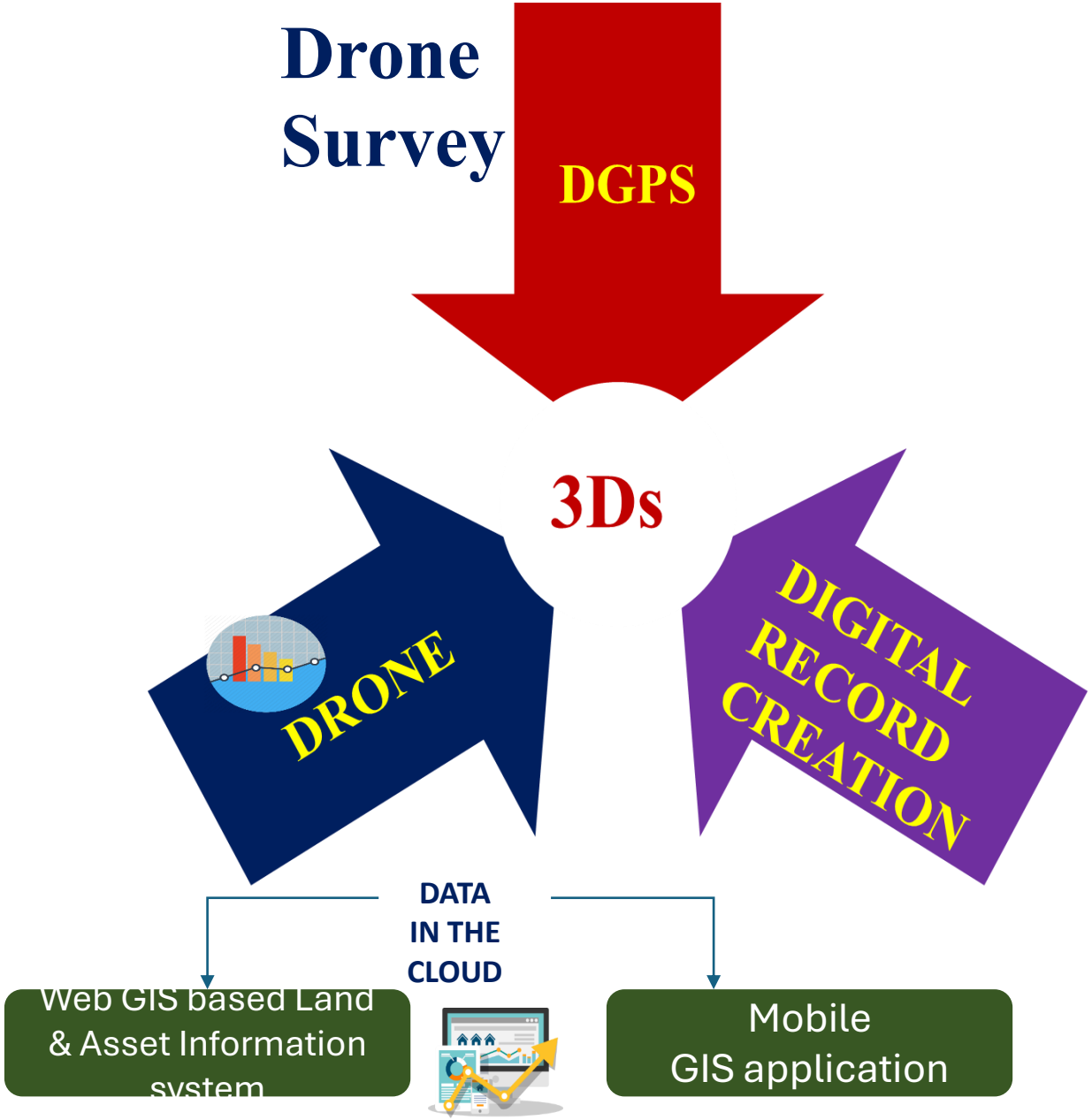
ORI From SOI

↓

Detail Field Survey

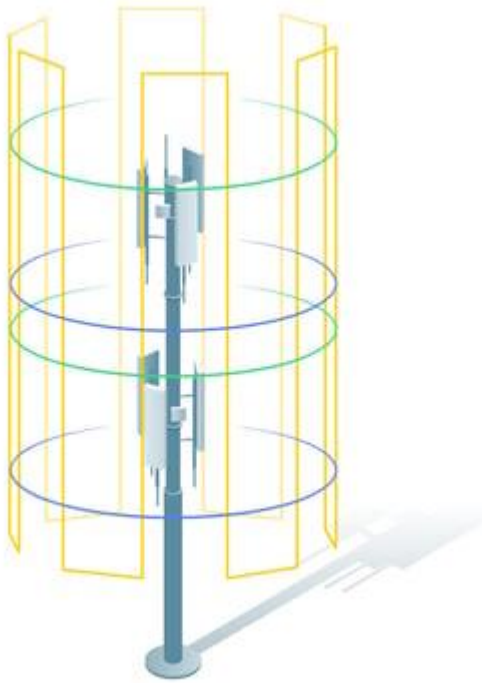
↓

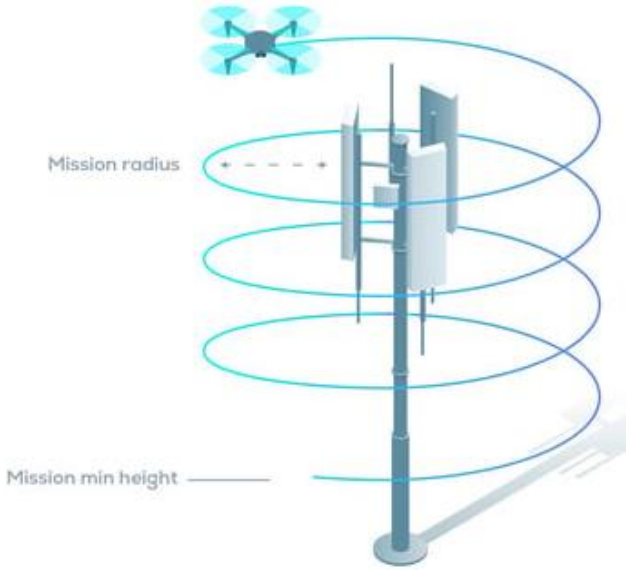
Digitization of Surveyed Data

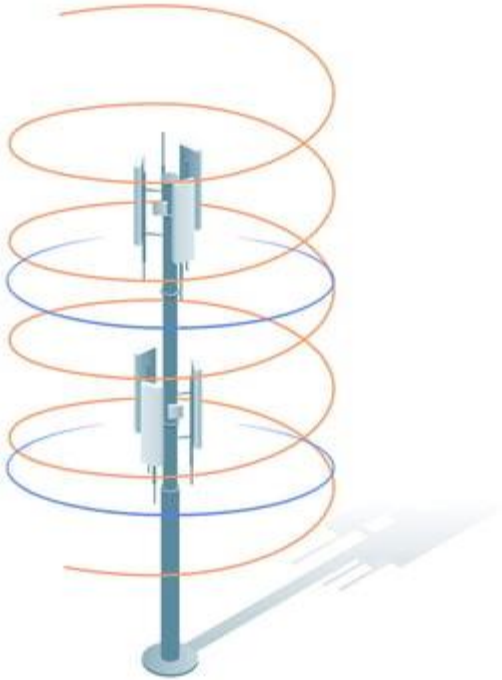


Flight Plan for inspection

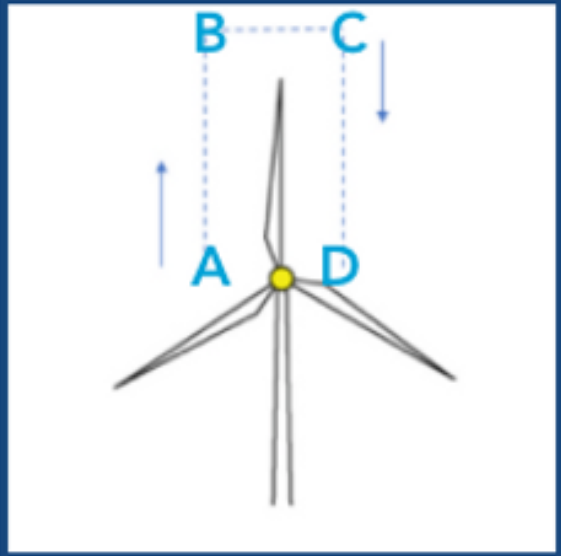
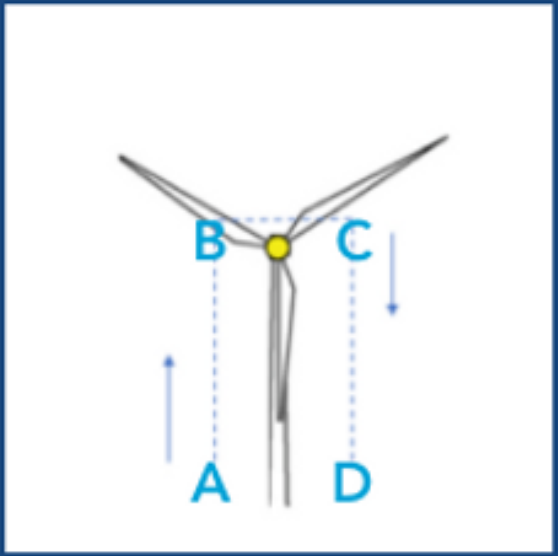
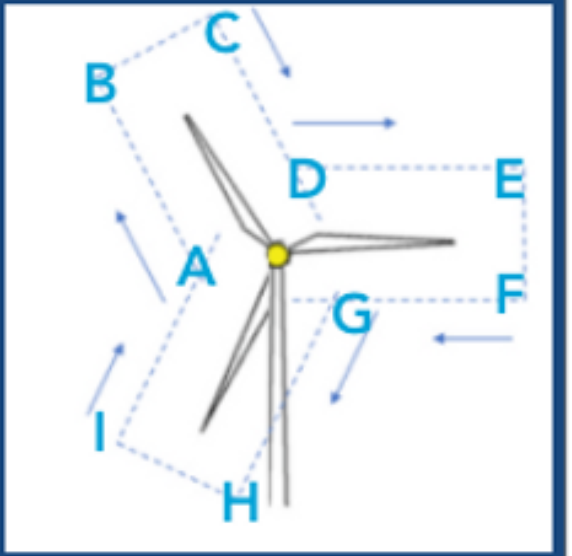
- Example Flight plan for Towers







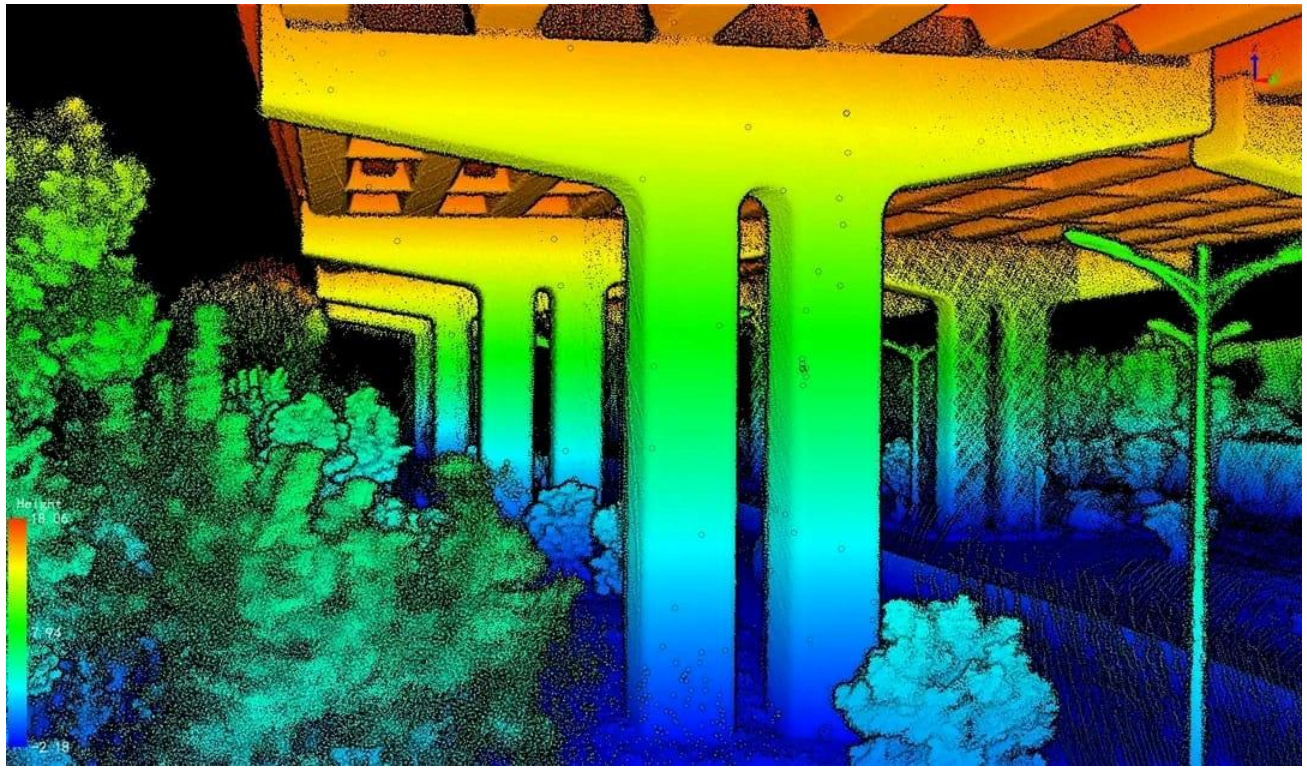
Position Of Wind Turbine for 3D modelling

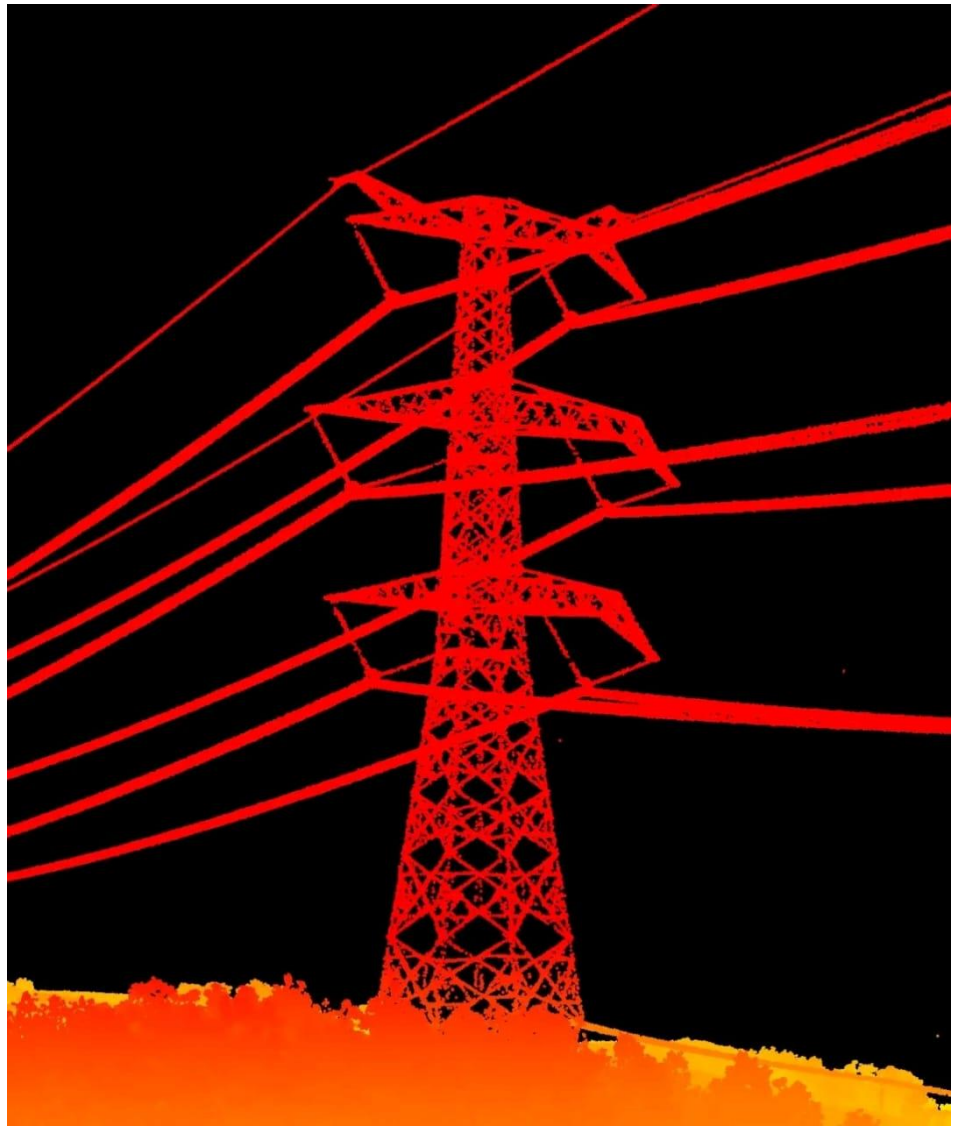
	12 O'Clock Position	6 O'Clock Position	Fixed Angle
Wind Turbine Inspection Using Drones			

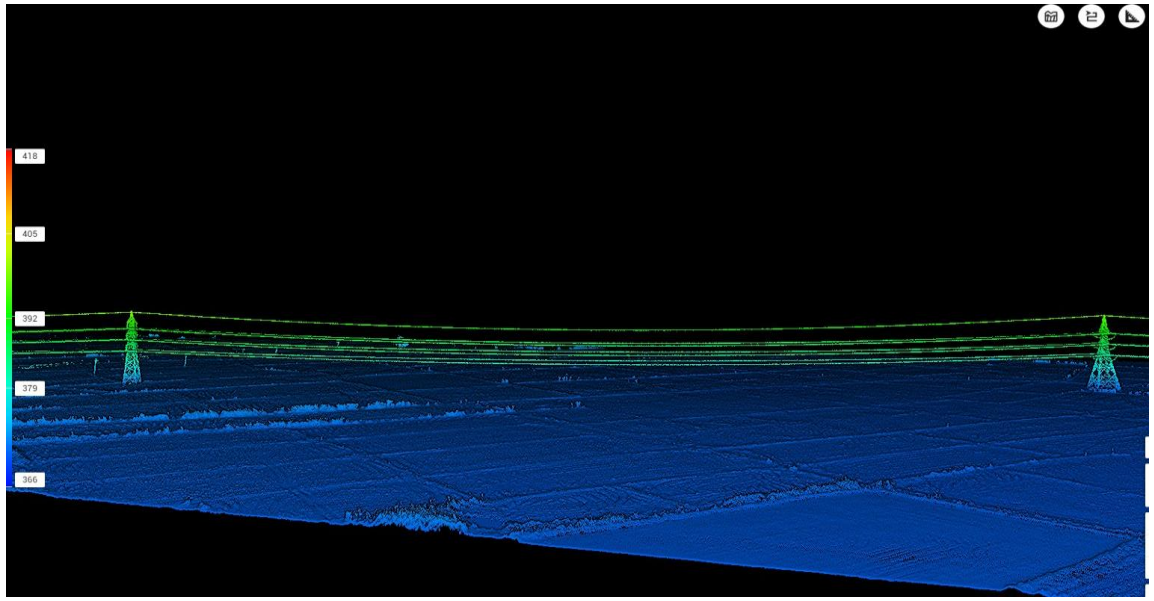
Methodology for Inspection and Modeling

Method	Payload	Use
Lidar & RGB	Zenmuse L2	(Wind Turbine 3D profile and 3D Model)
RGB	Zenmuse P1	High Resolution 3D Model(blade inspection)
Thermal & Zoom	H20T	Multi-sensor payload combining a wide camera, 200x zoom camera, Radiometric Thermal camera Thermal 3D Model and Inspection

Lidar Data Of Previous projects



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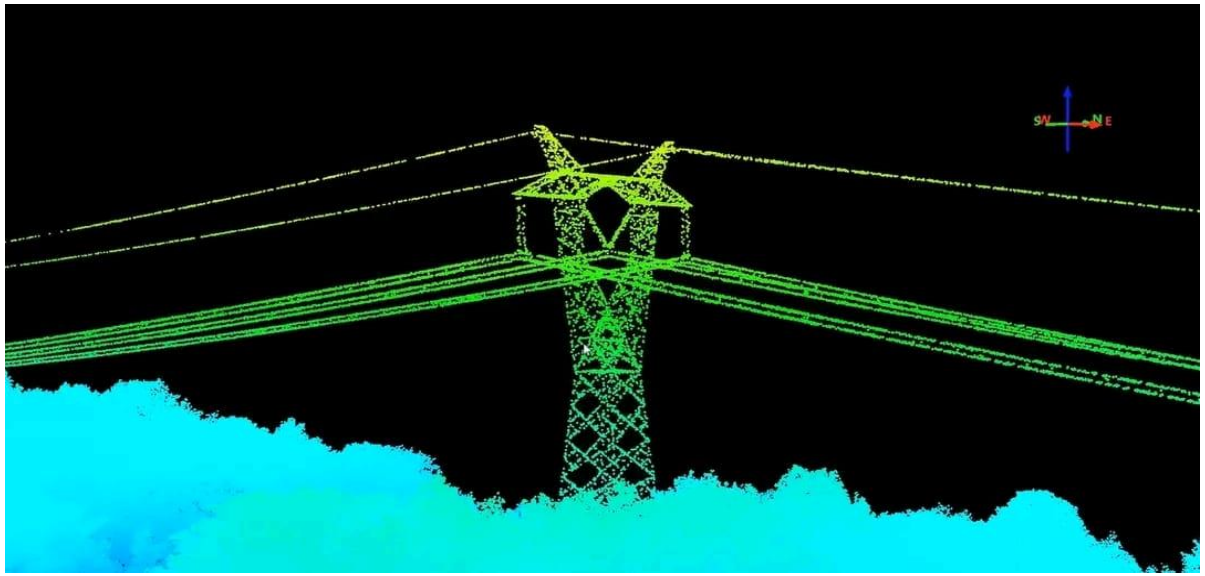
379
366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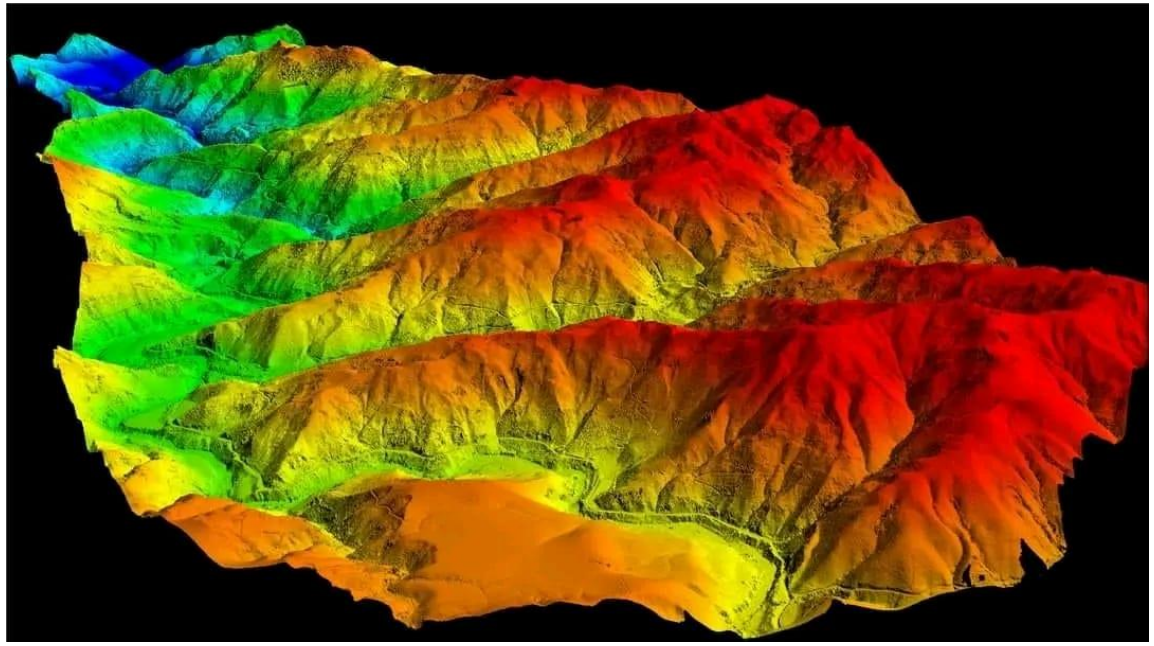

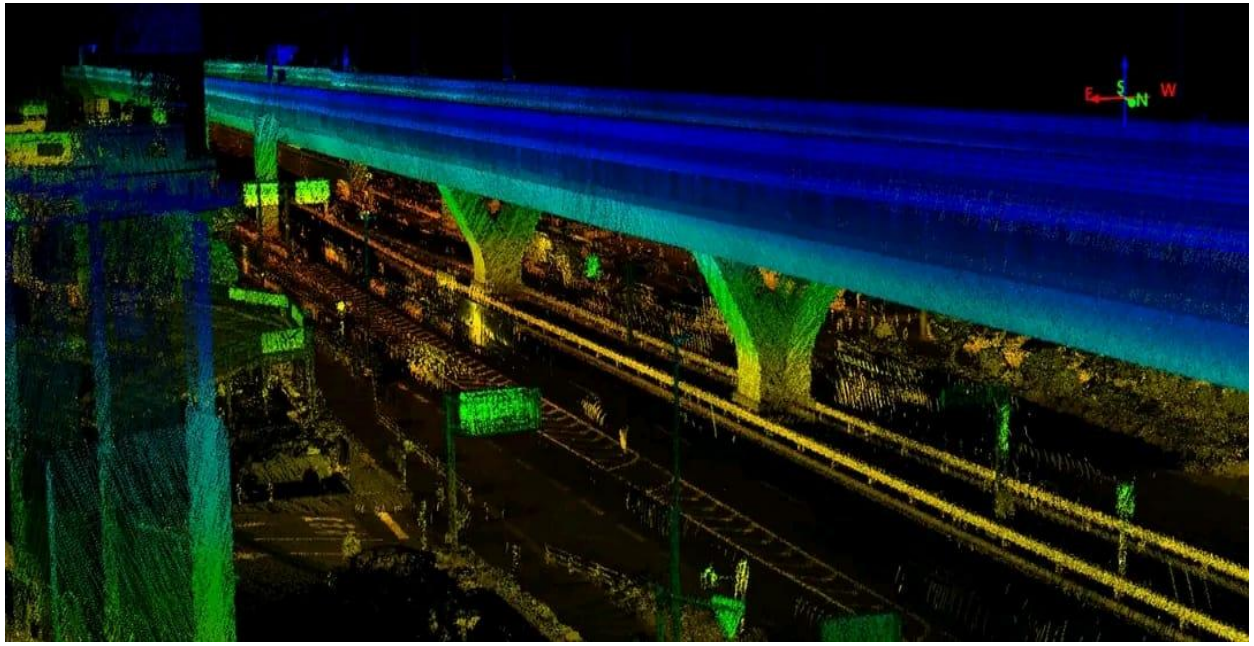
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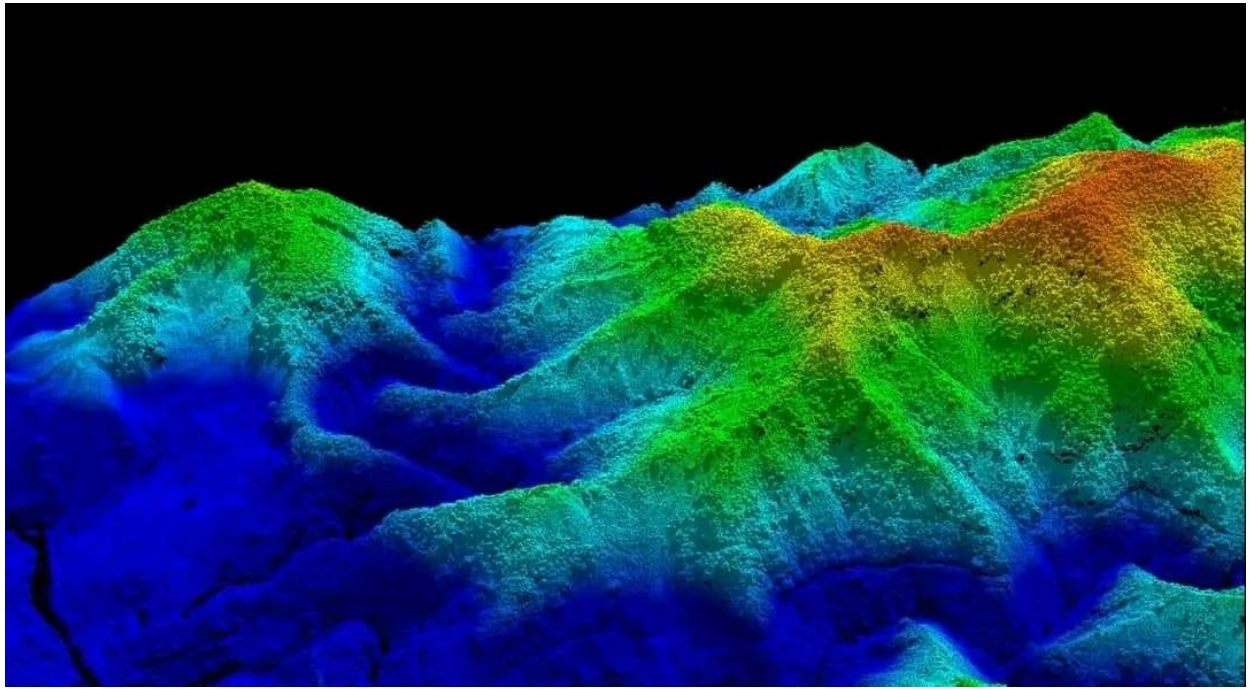

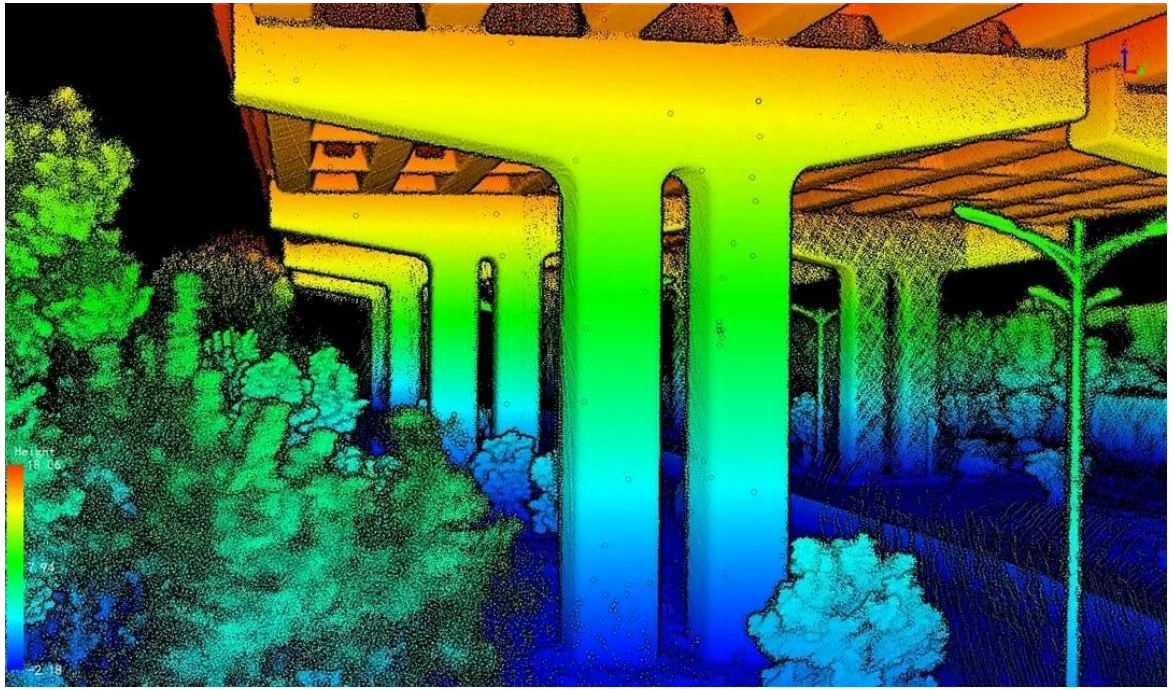

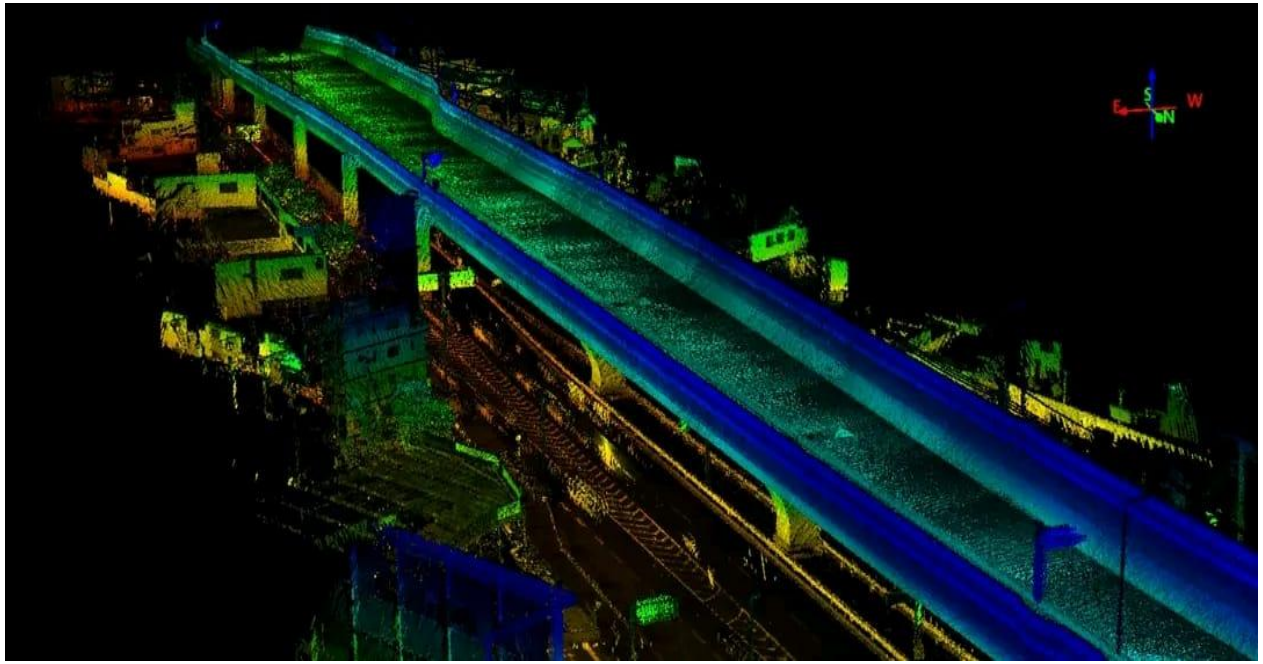
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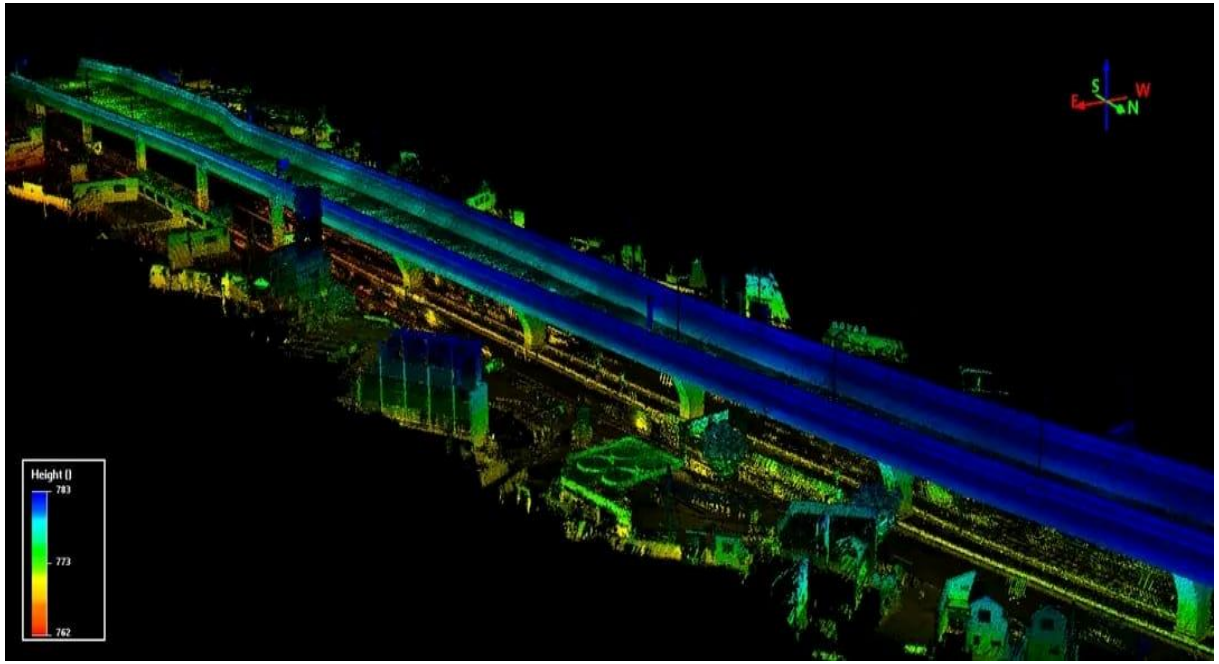
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Height ()
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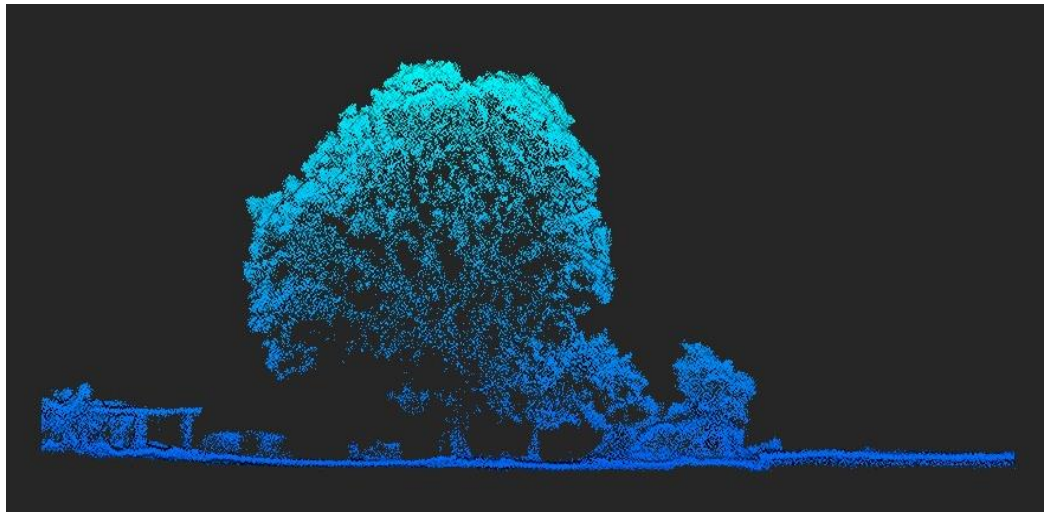

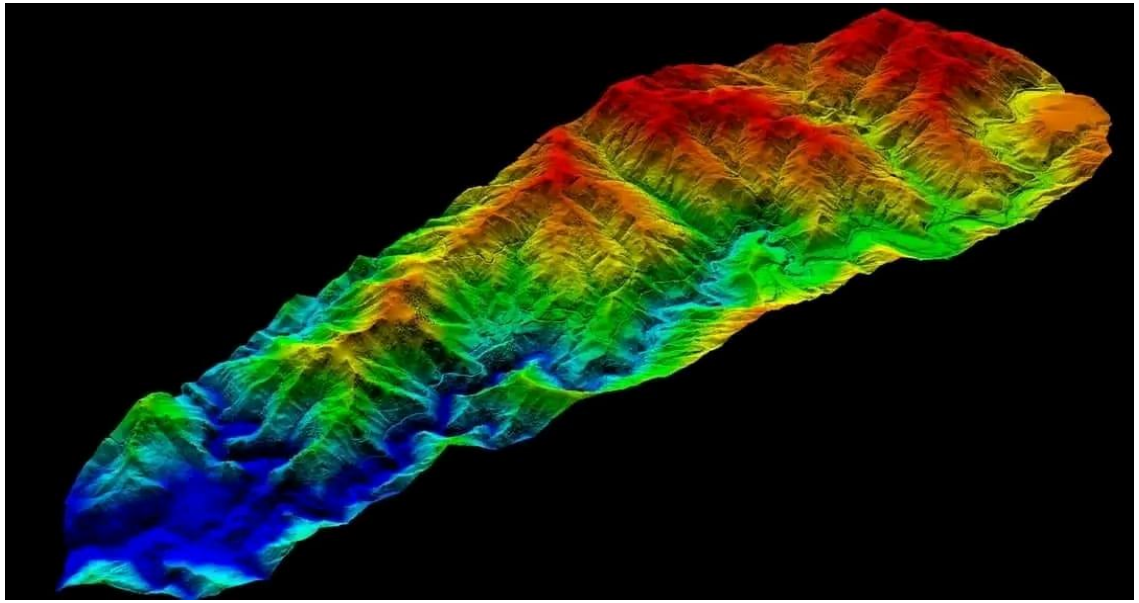

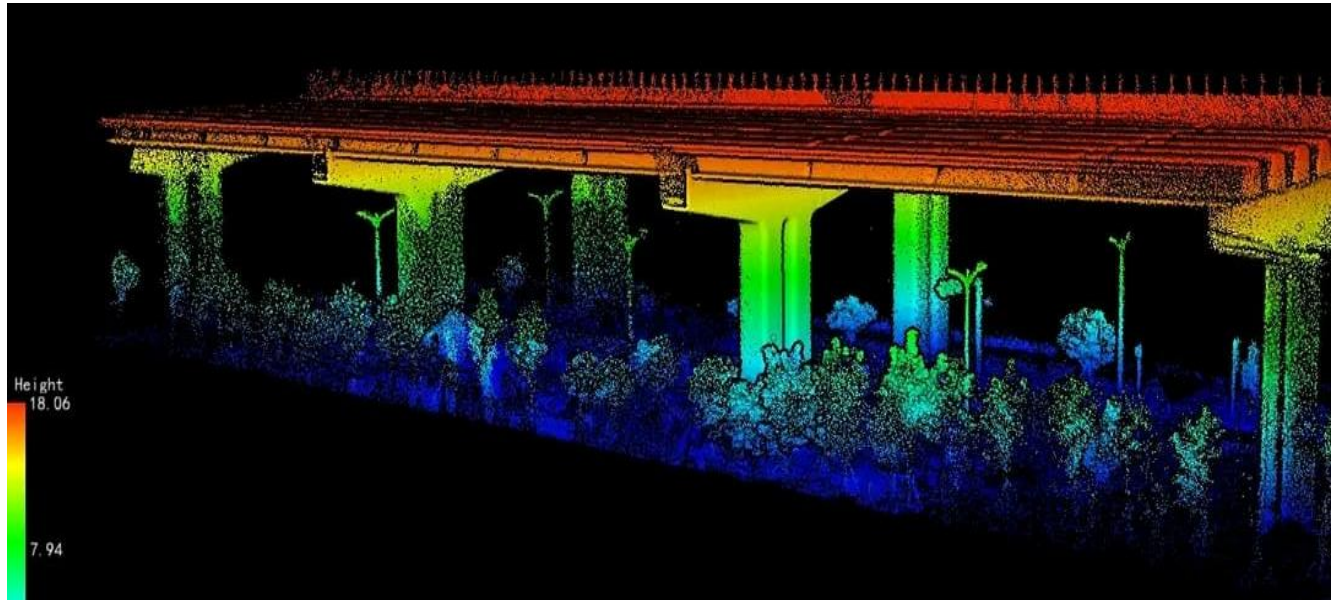
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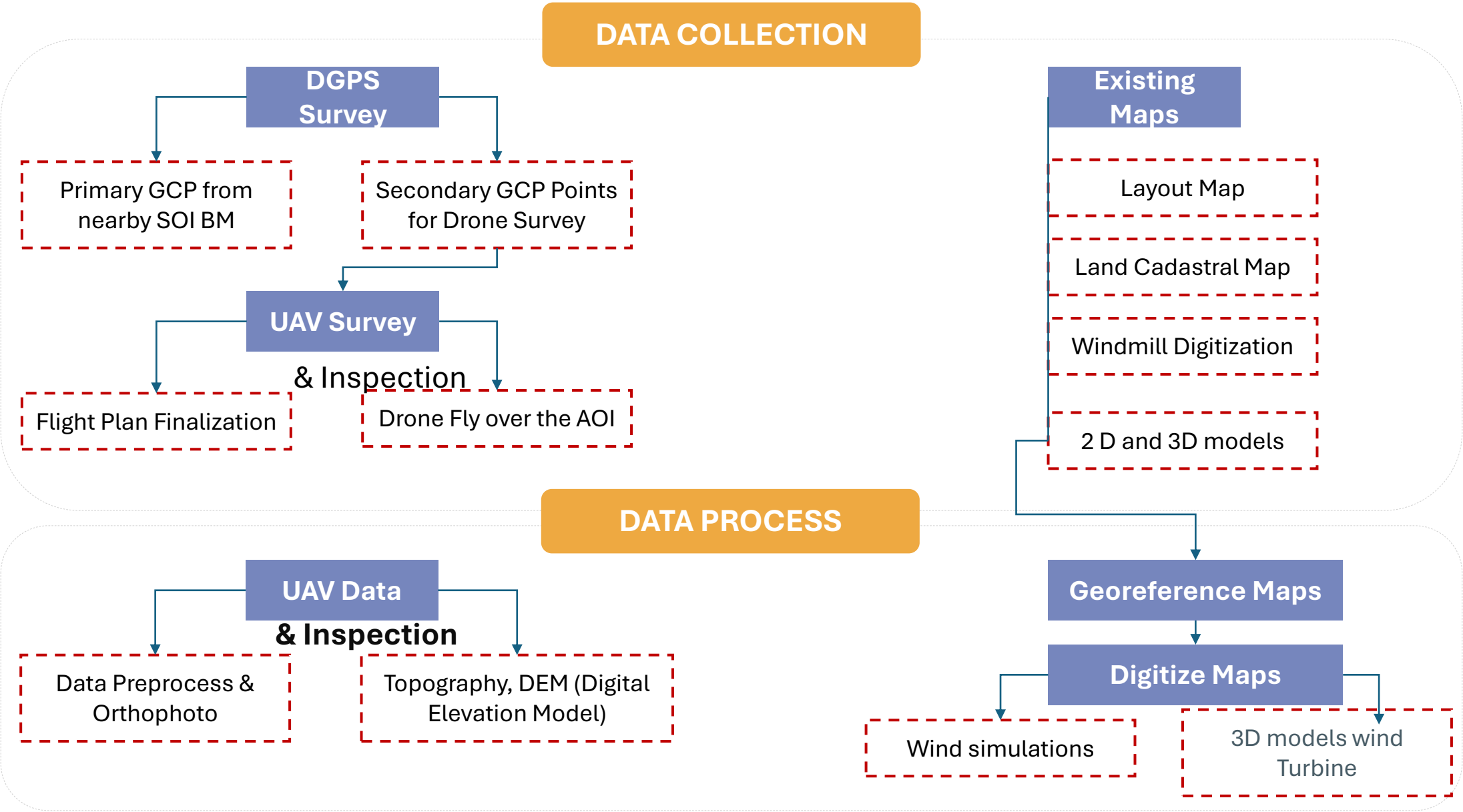
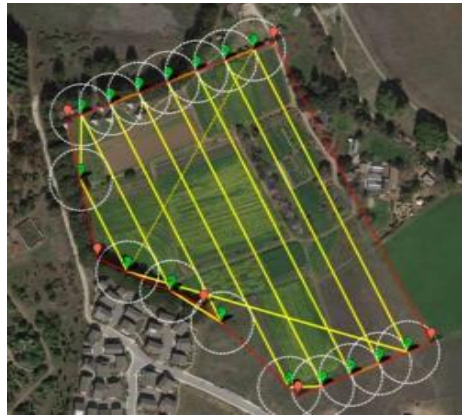
Methodology - Overview

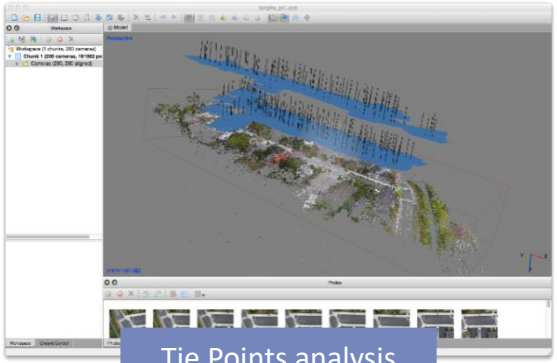


Data Processing – UAV Data Processing



Flight Planner

Aerial Triangulation



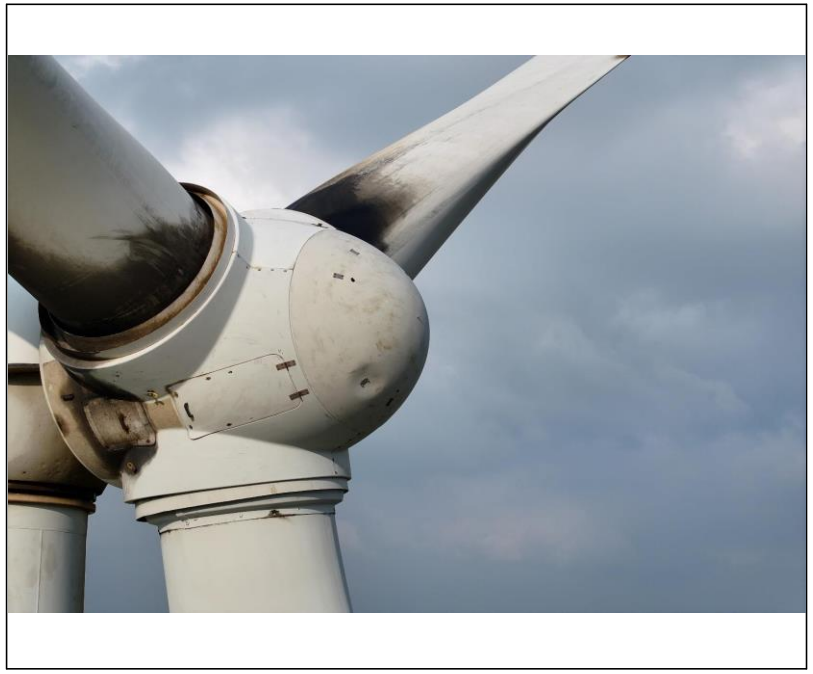
Tie Points analysis

Bundle Block Adjustment

Orthophoto

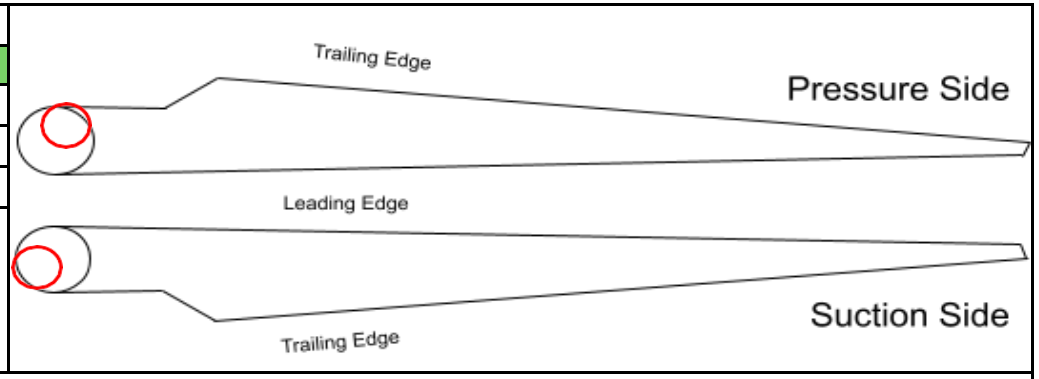
Damage Classification

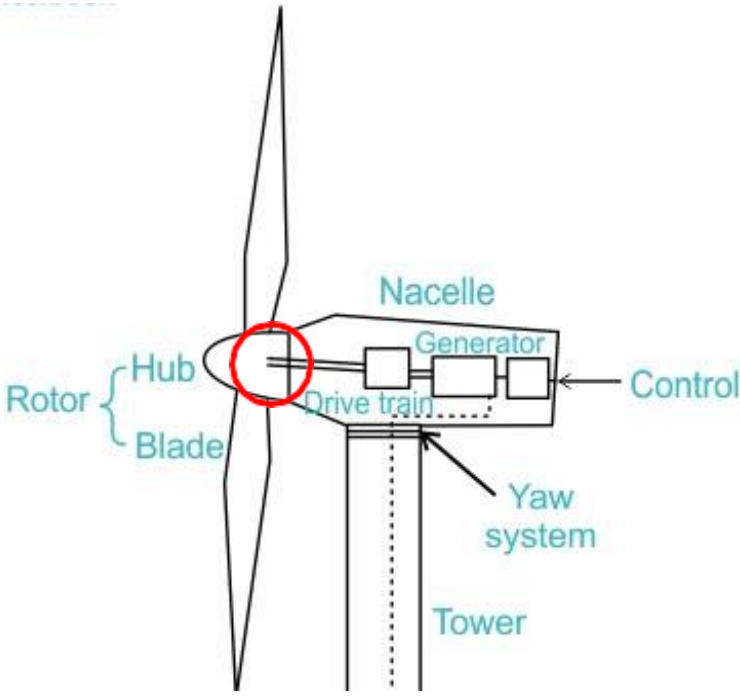
SEVERITY	DESCRIPTION	ACTION	TURBINE STATUS
1	Cosmetic	No intervention required	Continue Operation
2	Minor	Repair only if there are other damages to be repaired. Monitor at next inspection.	Continue Operation
3	Medium	Repair within 6 months	Continue Operation
4	Serious	Repair within 3 months	Continue Operation
5	Very Serious	Immediate intervention required to prevent further damage to blade, wind turbine, or surrounding area.	Stop Operation

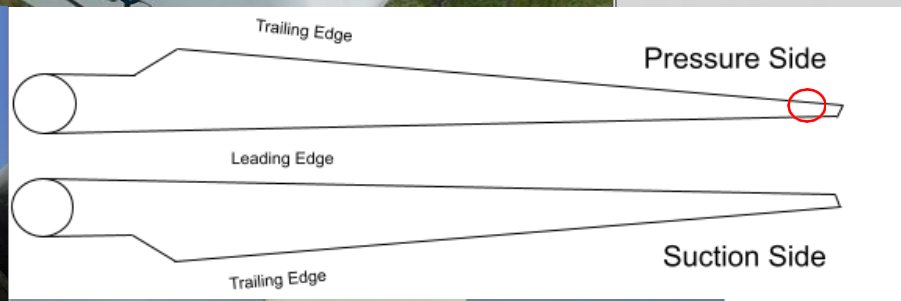


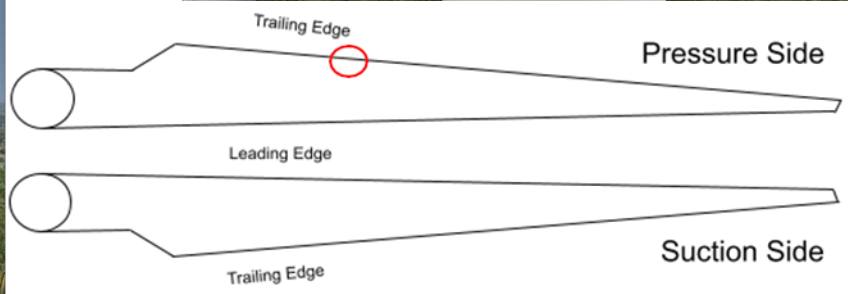
Wind Turbine Blade Inspection Report

Damage Reference	DN-01
Damage Catagory	CAT 2
Damage Type	Contamination
Blade Surface	-
Blade Letter/Number	All the 3 blades root
Image Ref.	
Description	Oily dirt accumulation in the roots of the blades






Trailing Edge
Pressure Side
Leading Edge
Suction Side
Trailing Edge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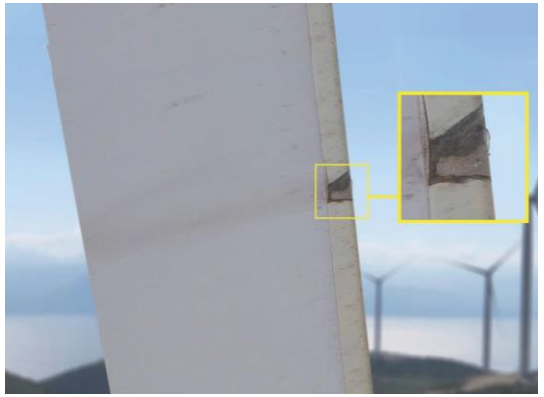
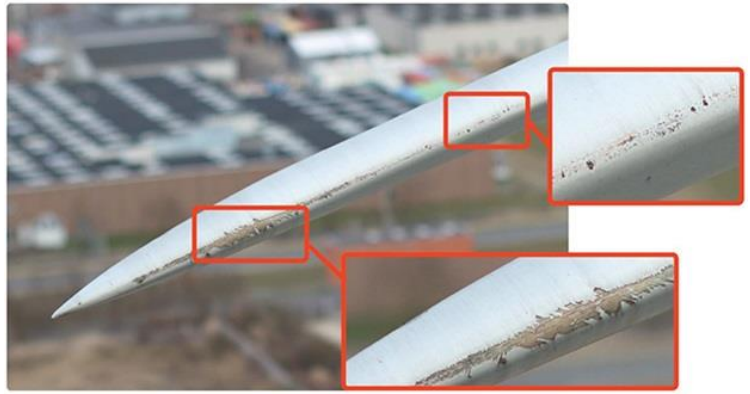
Pressure Side
Leading Edge
Suction Side
Trailing Edge



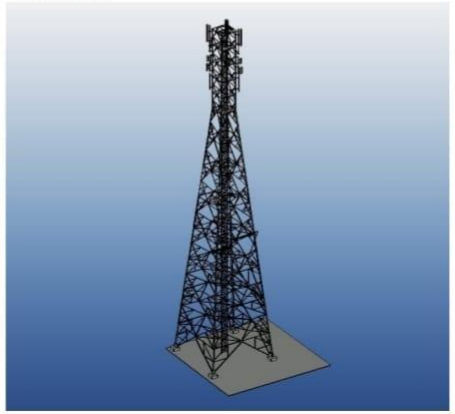


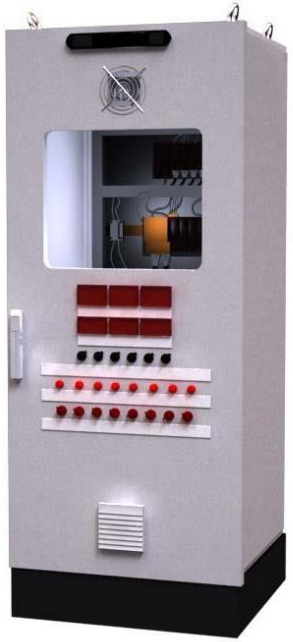
Leading edge
erosion

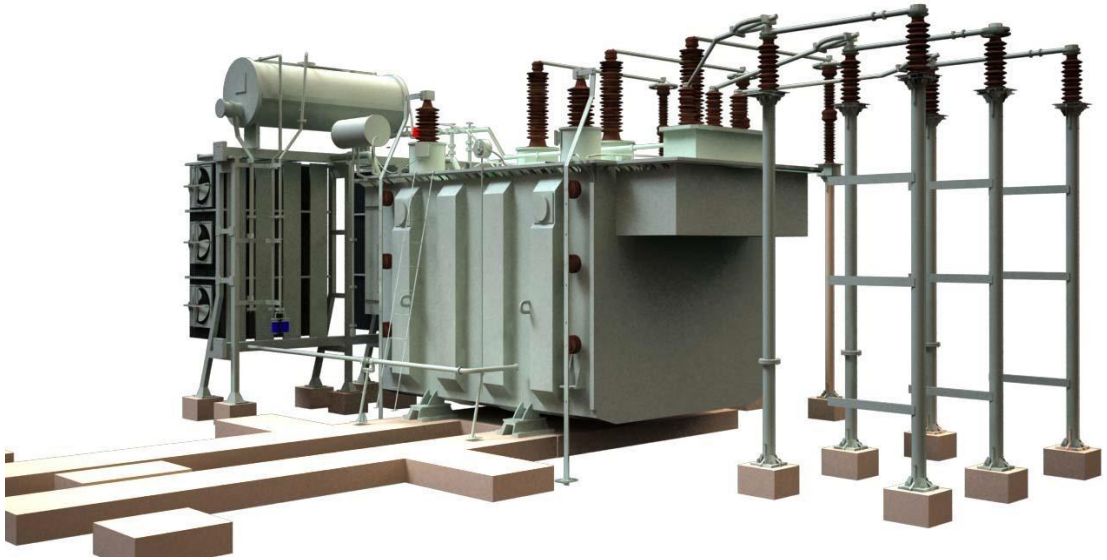
TOWER

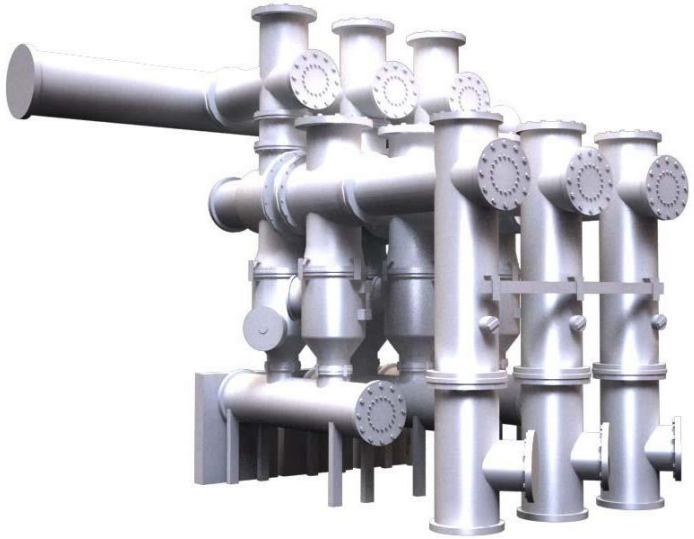
INPUT

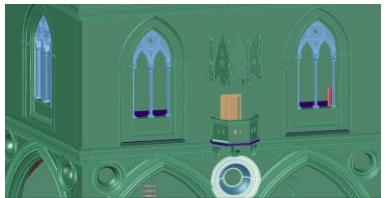
OUTPUT











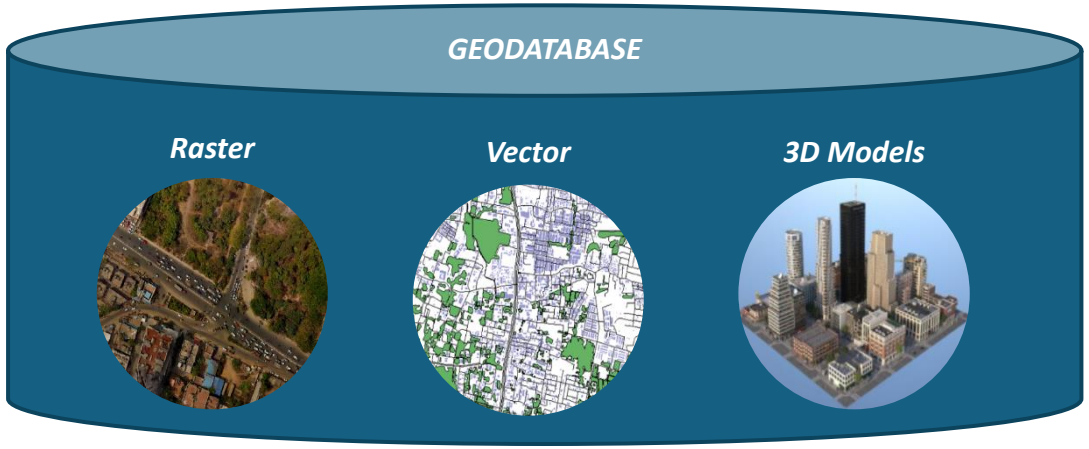
UAV / Drone Data Accompanied By High Resolution Imagery

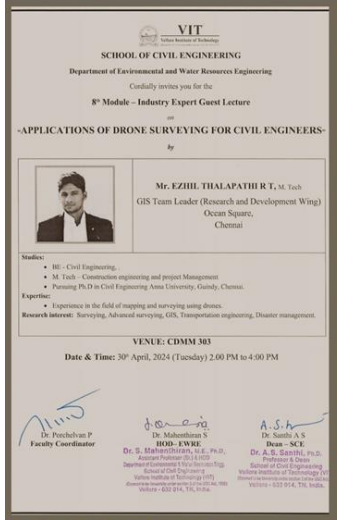
Geodatabase

RASTER DATA (ORI)

GIS & VECTOR DATA WITH ATTRIBUTES

3D MODEL





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Vellore Institute of Technology

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Department of Environmental and Water Resources Engineering

Cordially invites you for the

8th Module – Industry Expert Guest Lecture

on

-APPLICATIONS OF DRONE SURVEYING FOR CIVIL ENGINEERS-

by

Mr. EZHIL THALAPATHI R T, M. Tech
GIS Team Leader (Research and Development Wing)
Ocean Square,
Chennai

Studies:
- BE - Civil Engineering,
- M. Tech – Construction engineering and project Management
- Pursuing Ph.D in Civil Engineering Anna University, Guindy, Chennai.

Expertise:
- Experience in the field of mapping and surveying using drones.

Research interest: Surveying, Advanced surveying, GIS, Transportation engineering, Disaster management.

VENUE: CDMM 303

Date & Time: 30th April, 2024 (Tuesday) 2.00 PM to 4:00 PM

Dr. Porchelvan P
Faculty Coordinator

Dr. Mahenthiran S
HOD - EWRE
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Assistant Professor (Sr.) & HOD
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Vellore - 632 014, TN, India.

Dr. Santhi A S
Dean – SCE
Dr. A. S. Santhi, Ph.D.
Professor & Dean
School of Civil Engineering
Vellore Institute of Technology (VIT)
Deemed-to-be University under section 3 of the UGC Act, 1956
Vellore - 632 014, TN, India.

GPS Map Camera
Koomapatty, Tamil Nadu, India
JHVW+VPH, Koomapatty, Tamil Nadu 626133, India
Lat 9.644224°
Long 77.596506°
27/06/24 12:29 PM GMT +05:30
Google

GPS Map Camera
Koomapatty, Tamil Nadu, India
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GPS Map Camera
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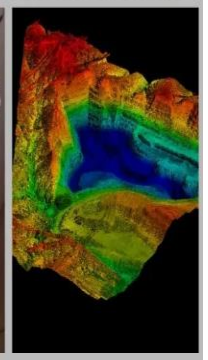
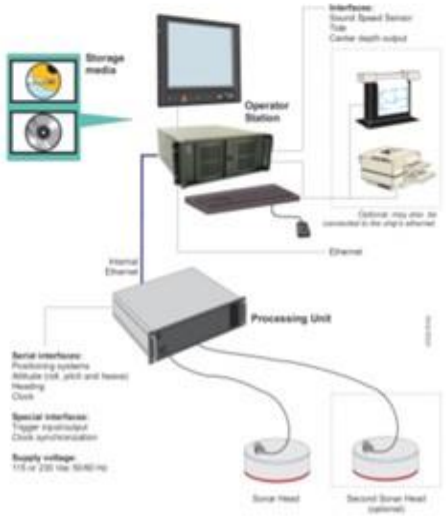
Road & Highways	Railway & Metro	Water & Irrigation
Urban	Energy	Mining
Oil & GAS	Power & Transmission line	Archaeology
Agriculture	Forest	Network



KARNATAKA
ANDHRA PRADESH
Nellore
99+
Mysuru
Bengaluru
22
22
14
TAMIL NADU
Madurai
KERALA
1
Thiruvananthapuram
Sri Lanka
Colombo
Laccadive Sea
Galle

RCM 9 LW
AANDERAA

OLYMPUS
X


Storage media
Operator Station
Processing Unit
Sonar Head
Second Sonar Head (optional)

Geoscience Software

GIS

NOW AVAILABLE ENVI 5
THE NEXT GENERATION OF IMAGE ANALYSIS

GEMCOM SURPAC

esri

PCI Geomatics

erdas
The Earth to Business Company

GIS/Remote Sensing

Global Mapper

MapInfo

Golden Software

Mining

MICROMINE
Intuitive Mining Solutions

Micromine
Surpac

Arcgis
ERDAS - ENVI
Mapinfo Encom Discover
Geosoft Oasis Montaj
Global Mapper
Golden software
Autocad
IDRISI
River Tools
Bentley
WMS
LandSerf
MicroDEM

Geology

GEOSOFT

Surveying

Autodesk

AutoCAD

Bentley

Geomorphometry

idrisi

Hydrology

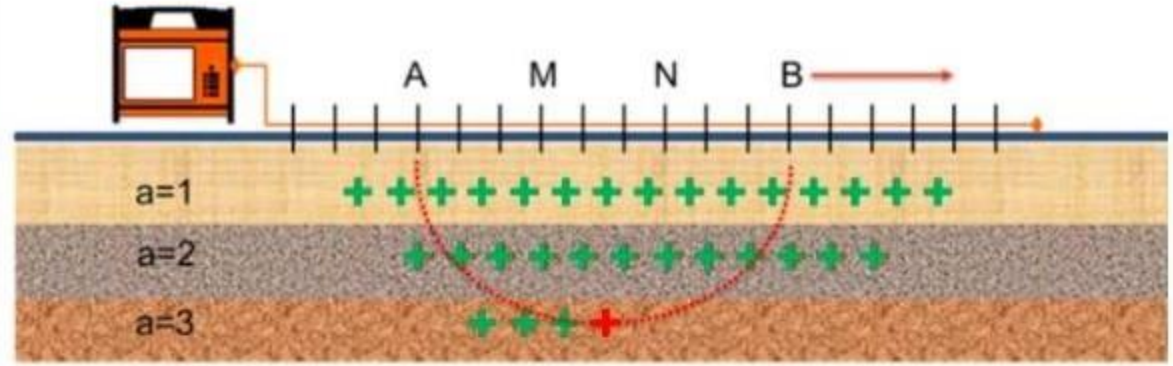
WMS

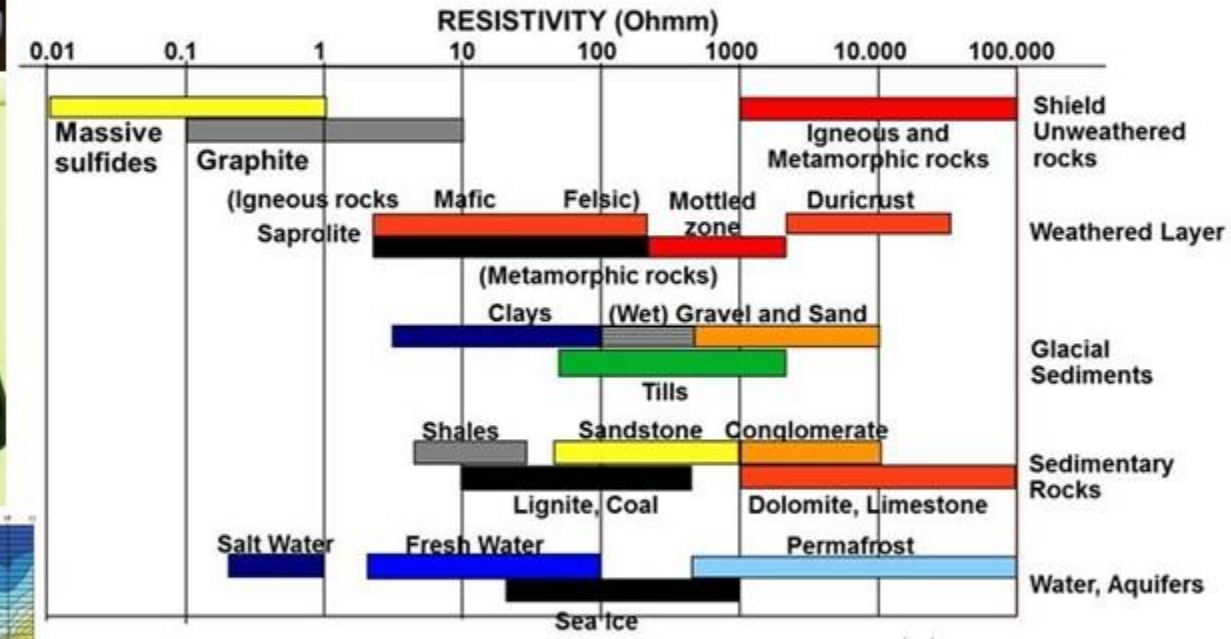
Tray
Brush
Trowel
Sieve Shaking Machine
Sieve lid
Tamping rod
sand
Balance
Sieve
Larson Davis

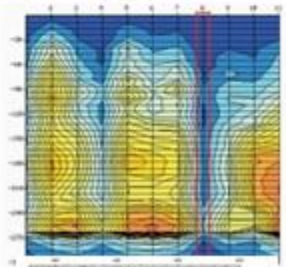
RCM 9 LW
SCINTREX
GIS-3 GAMMA-RAY
SPECTROMETER
Operator Station
Processing Unit
Storage media

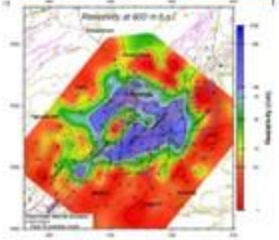
Underground Water Detector

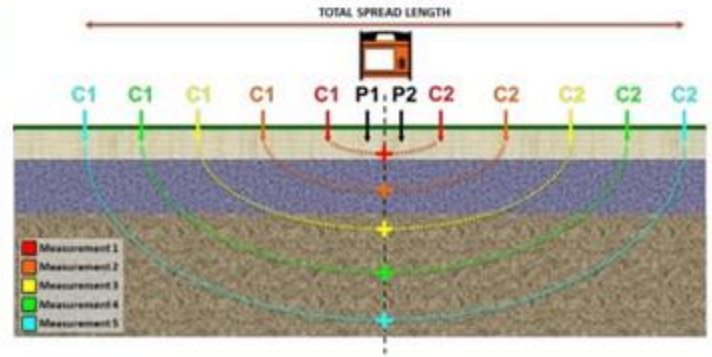
RESISTIVITY METER
MODEL SSR-MP-ATS
DISPLAY
RESET
TO - PC
FUSE

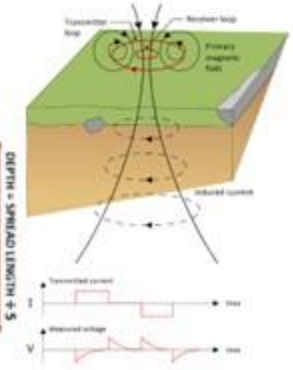

A
M
N
B
a=1
a=2
a=3

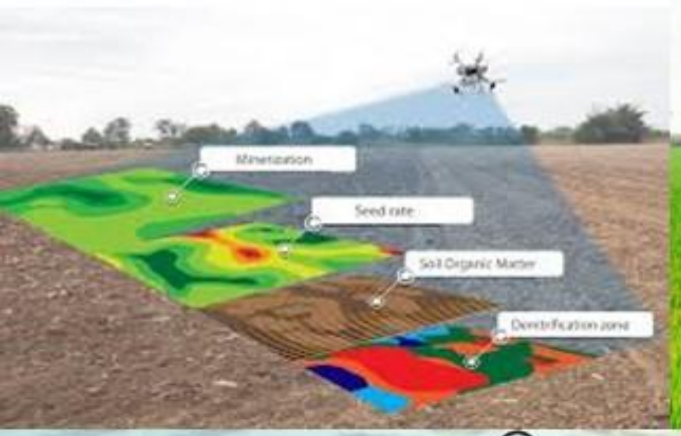

RESISTIVITY (Ohmm)
0.01
0.1
1
10
100
1000
10.000
100.000
Massive sulfides
Graphite
Igneous and Metamorphic rocks
Shield Unweathered rocks
(Igneous rocks
Mafic
Felsic)
Mottled zone
Duricrust
Saprolite
Weathered Layer
(Metamorphic rocks)
Clays
(Wet) Gravel and Sand
Tills
Glacial Sediments
Shales
Sandstone
Conglomerate
Lignite, Coal
Dolomite, Limestone
Sedimentary Rocks
Salt Water
Fresh Water
Permafrost
Sea Ice
Water, Aquifers



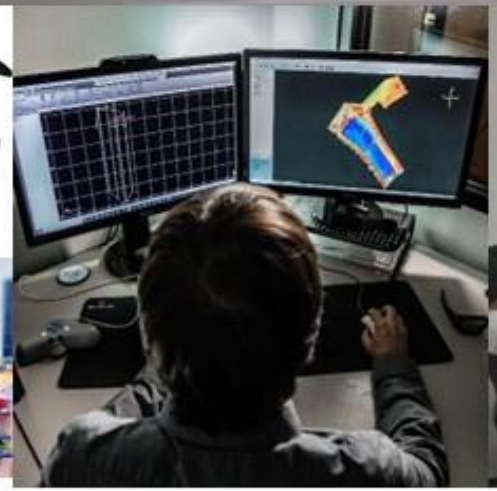



TOTAL SPREAD LENGTH
C1
C1
C1
C1
C1
P1
P2
C2
C2
C2
C2
C2
Measurement 1
Measurement 2
Measurement 3
Measurement 4
Measurement 5




Mineralization
Seed rate
Soil Organic Matter
Denitrification zone

Science
Technology
Agriculture



FUTURE SKILLS