AMUSE ONESELF

TDOT

DRONE LIDAR SYSTEM

SERIES

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TDOT

DRONE LIDAR SYSTEM

SERIES

FOREST RIVER COAST

Cover all “TOPOGRAPHIC DATA” and visualize

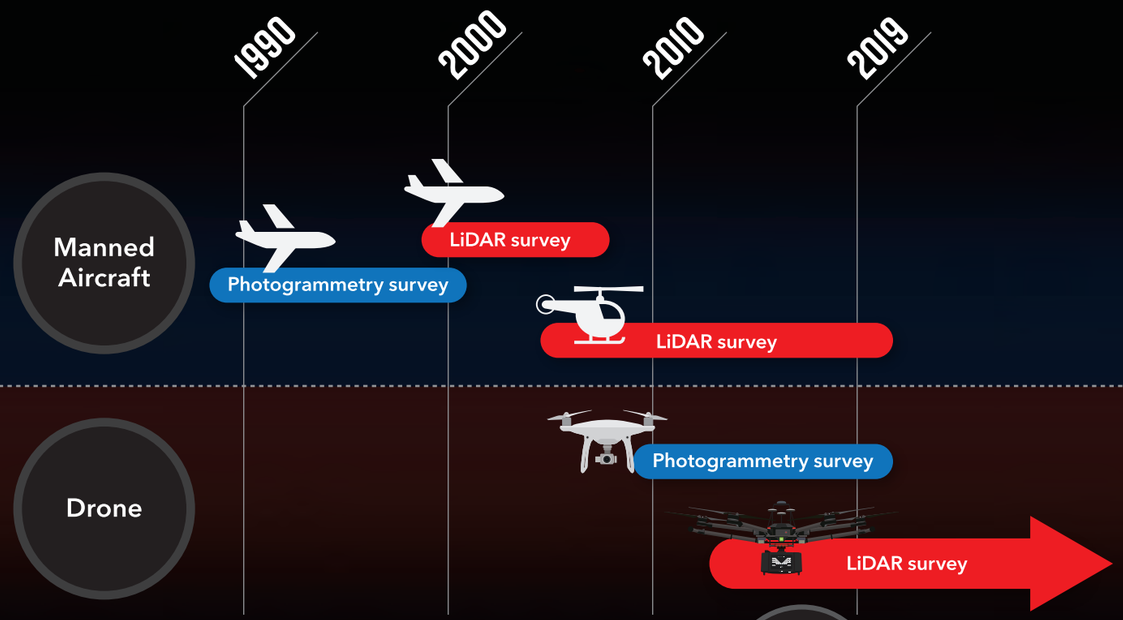
“TDOT” DRONE LiDAR SYSTEM

LIGHTWEIGHT COMPACT HIGH ACCURACY

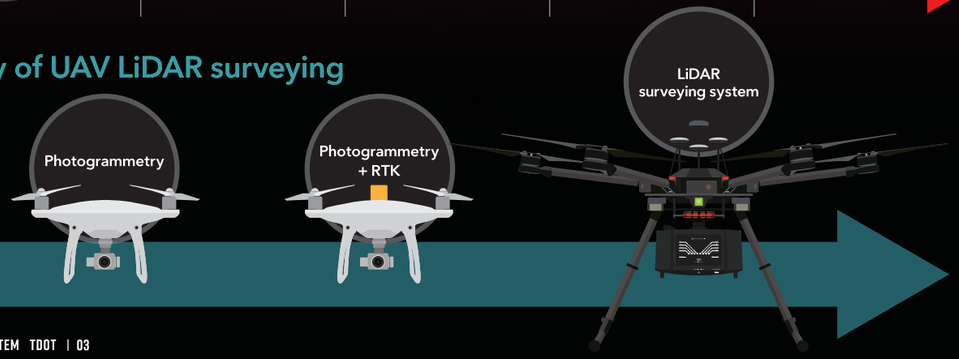
Change surveying and measurement work flow

INTRODUCTION

History of Aerial LiDAR surveying



History of UAV LiDAR surveying



Difference between Photogrammetry and LiDAR surveying

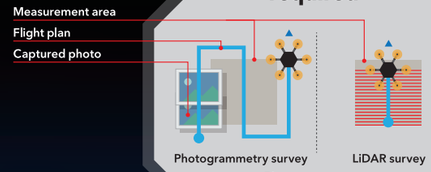
- Photogrammetry surveying analyzes lots of continuous photos which deployed geometrically. Work flow of photogrammetry requires lots of time. Accuracy will rely on photo resolution and overlap rate for target area.
- LiDAR survey measures target directly and analyzes captured data. Accuracy will rely on GNSS and IMU.

Advantages of drone

High Versatility

Possible to do work although operator is not land surveyor.

No side lap required

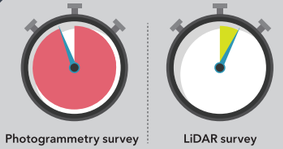


<Photogrammetry>
Require outside field flight
<LiDAR>
Complete inside of field

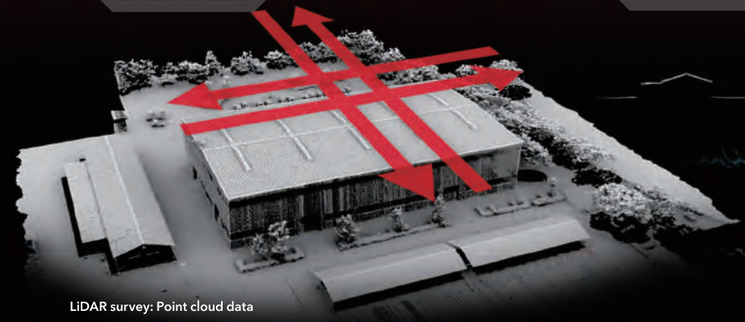
High Productivity

Getting a few days of work done in just a few hours

Short analysis time

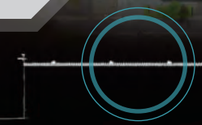


Able to shorten the time compared with photogrammetry survey analysis.

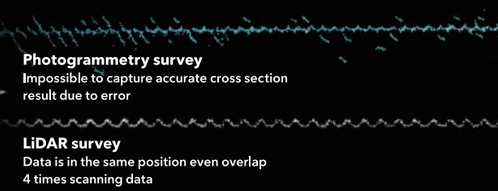


LiDAR survey: Point cloud data

Photogrammetry survey: Orthophoto



Cross section



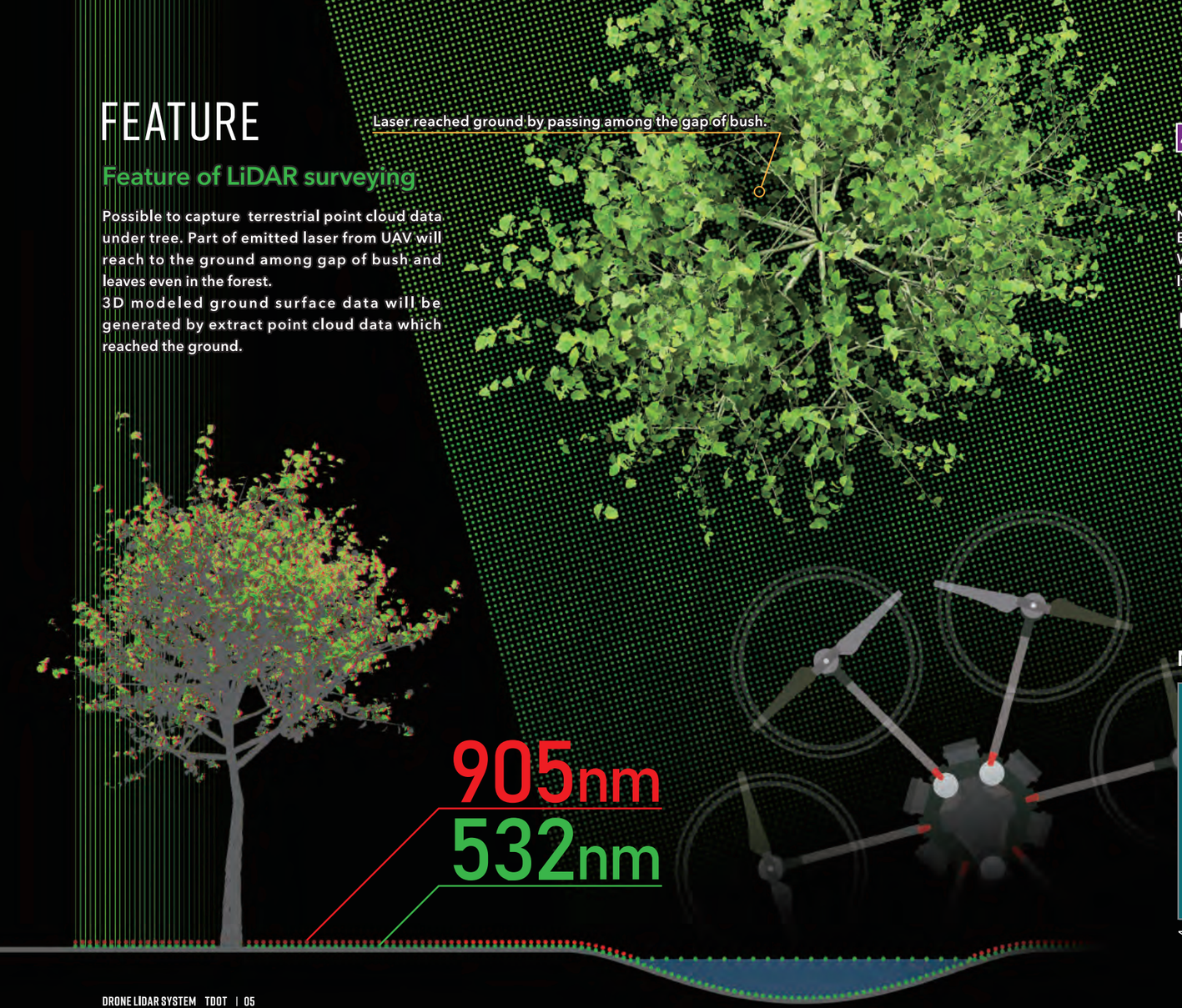
Photogrammetry survey
Impossible to capture accurate cross section result due to error

LiDAR survey
Data is in the same position even overlap 4 times scanning data

FEATURE

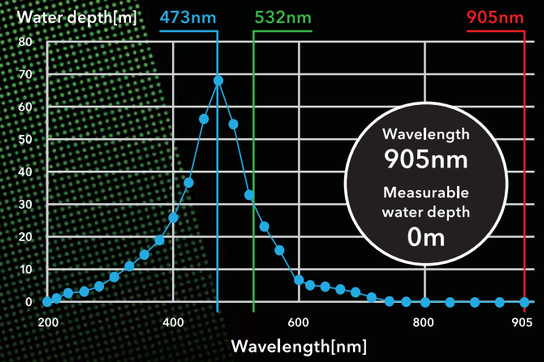
Feature of LiDAR surveying

Possible to capture terrestrial point cloud data under tree. Part of emitted laser from UAV will reach to the ground among gap of bush and leaves even in the forest.
3D modeled ground surface data will be generated by extract point cloud data which reached the ground.

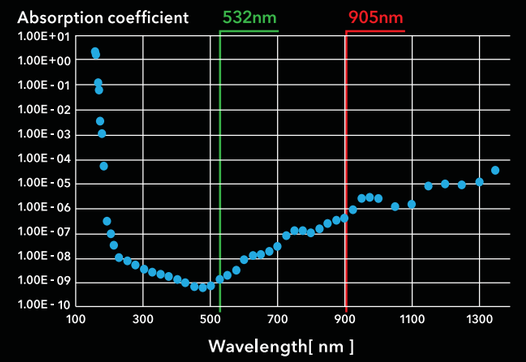


Normal laser scanners use 905nm wavelength near infrared laser.
Because near infrared laser will be absorbed by black object or wet area, the data cannot be captured.
Whereas, 532nm wavelength green laser have low absorption, reflection echo will return.
It is possible to capture point cloud data on black object, wet surface and water area.

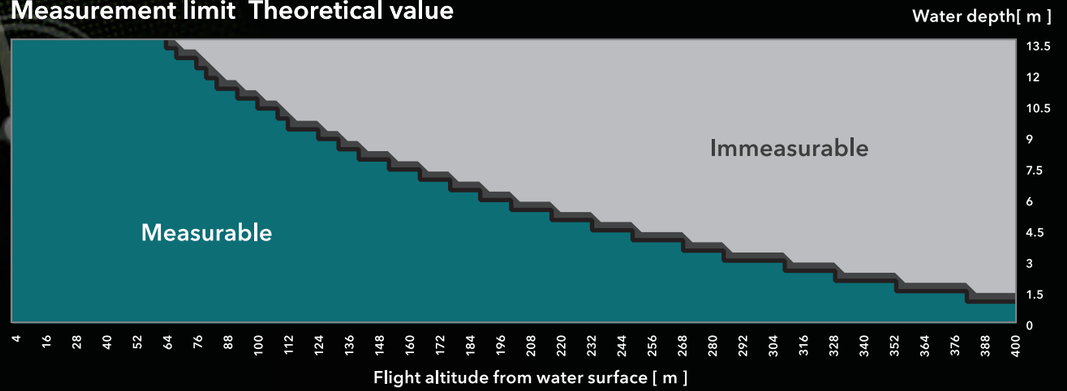
Measurable water depth



Absorption rate for water



Measurement limit Theoretical value



FEATURE

Lightest weight in class

TDOT PLUS **1.8kg** TDOT GREEN **2.6kg**

Possible for long flight

- Special designed compact and light weight body.
- The best in the class light weight LiDAR system.

Accuracy

Required accuracy for ICT work

±50mm*

(Mean square error of elevation value 24mm. Max. difference 46mm)

- Achieved requirement accuracy for ICT work.
- TDOT can provide practical accuracy level.

*Accuracy depends on quality of GNSS.

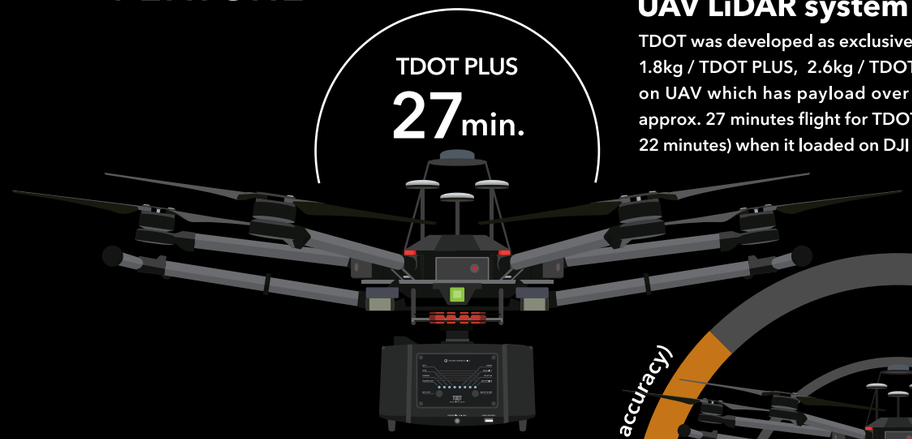
User friendly

Optimal base line analysis was difficult task but TDOT system can be done by online automated service. Possible to provide result data very short time by using online service.

Excellent footwork

It is very portable by hand carry. TDOT can be loaded on drone which has more than 3kg payload.

FEATURE

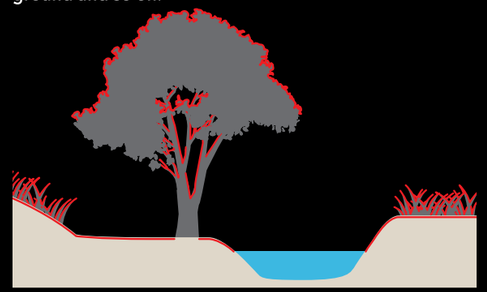


High accuracy INS integrated UAV LiDAR system

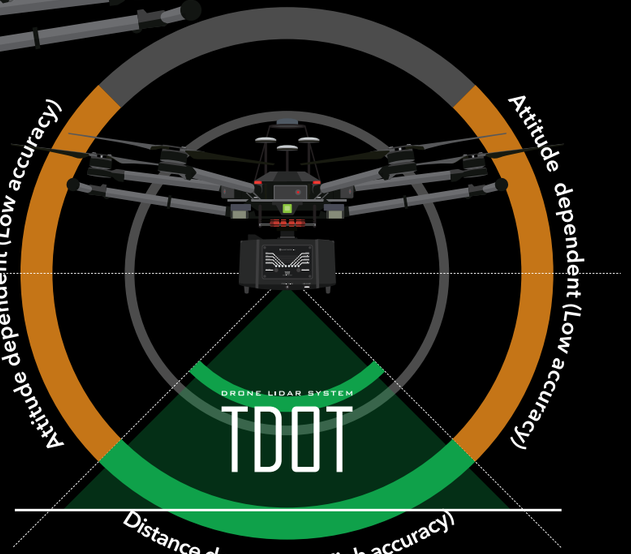
TDOT was developed as exclusive system for UAV and it weights 1.8kg / TDOT PLUS, 2.6kg / TDOT GREEN. TDOT can be loaded on UAV which has payload over 3kg. For example, maximum approx. 27 minutes flight for TDOT PLUS (TDOT GREEN: approx. 22 minutes) when it loaded on DJI Matrice600Pro.

Multi echo support

Each emitted laser pulse can capture maximum 4 reflection echoes. At the result, you can capture more and more data like crown, branch, body of tree, ground and so on.

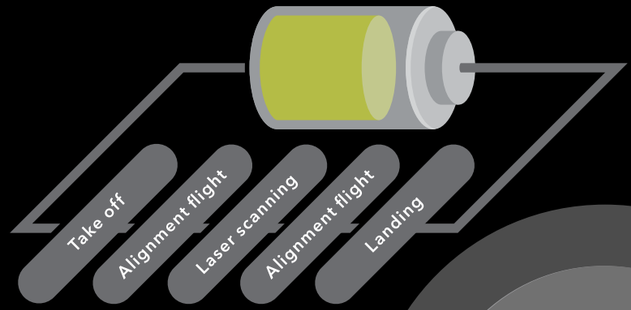


* INS: Inertial Navigation System
INS is high accuracy position & attitude sensor by combining GNSS and IMU. GNSS itself cannot achieve high accuracy positioning information unlike INS integrated system can do.



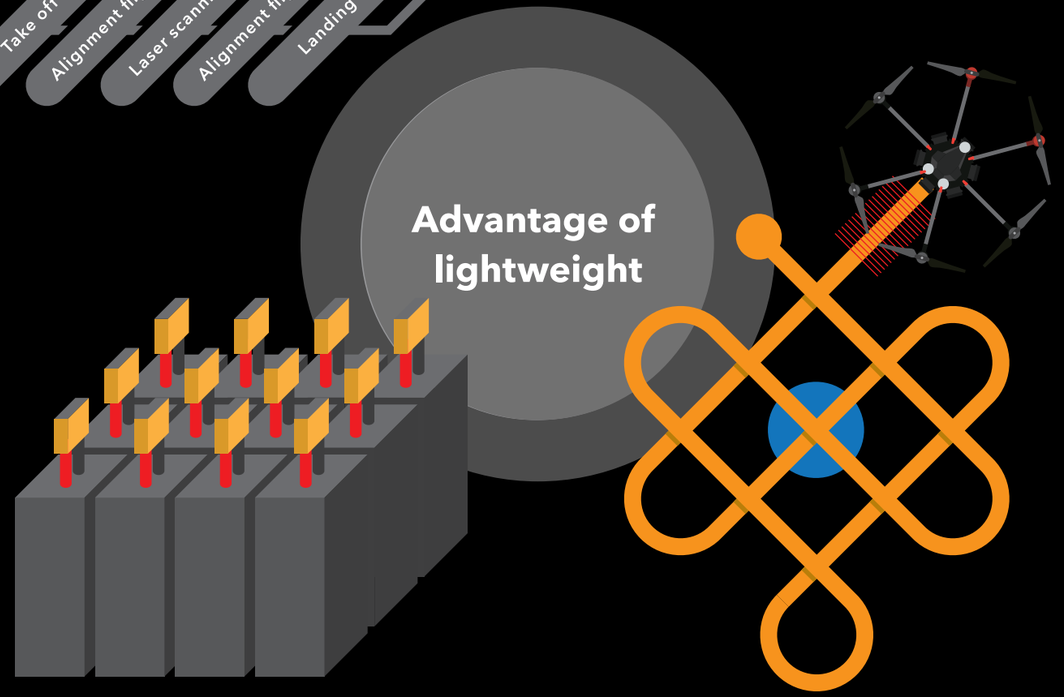
240,000 pulse/sec for 360 degree

Surveying from air can measure ground surface high density and high accuracy. All around scanning laser system has notably low height accuracy for side measurement compared with right below measurement. Whereas, TDOT provides stable accuracy result in order to limit 90 degree vertical laser emission.



1 Flight time

Lightweight can provide drone more longer flight time. Therefore, TDOT achieves seamless work flow from take off, alignment flight, scanning and landing.



2 Footwork

Large class drones increase weight in proportion to battery weight so operation efficiency can be lower. TDOT is very lightweight body which allow middle class drone efficient operation

3 Multiple direction scanning

Longer flight time allow multiple direction scanning. Needless to say, better to scan by multi direction in order to capture more and more ground surface point cloud data.

WORK FLOW

Field work

1 Alignment flight (IMU calibration)

Alignment flight approx. 1min. for calibration IMU which is integrated inside of TDOT.

Approx. **1 min**

2 Scanning flight

After alignment flight, start scanning flight without landing the drone. In case of wide range scanning, continue scanning by changing batteries repeatedly. Finally, do the alignment flight again.

Max. / 1 flight **27 min**

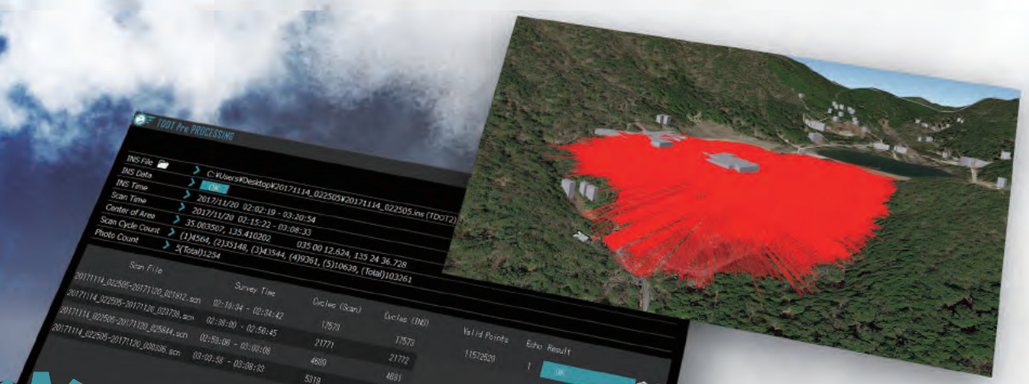
Mount on DJI Martice 600 Pro

Short time scanning of wide range surveying area, and data conversion

The strength of laser scanning is to capture 3D data directly.
Capturing 3D data of whole field by only several minutes

Available to check the data at field

There will be possibilities to scan again by missing and error of surveying area.
To avoid scanning again, providing tools which can check captured range at field.
By preview application, work efficiency will be improved by secure data capturing.



Check scanning area

TDOT Pre PROCESSING

Preview application **Bundle**

High speed point cloud processing application which specialized for checking at field.

3 Preview

Capture data is OK or not? Captured point cloud cover necessary area, or not? Captured terrestrial point cloud data under trees, or not? etc.. TDOT can check them within a few minutes. This is outstanding application to prevent various troubles.

3 min

Point cloud viewer

WORK FLOW

Processing

1 Data upload

Upload data to cloud service.

POST-PROCESSING CLOUD

Online processing

Pay-as-you-go system

2 Data download

Download the data which automatic processed optimal baseline analysis.

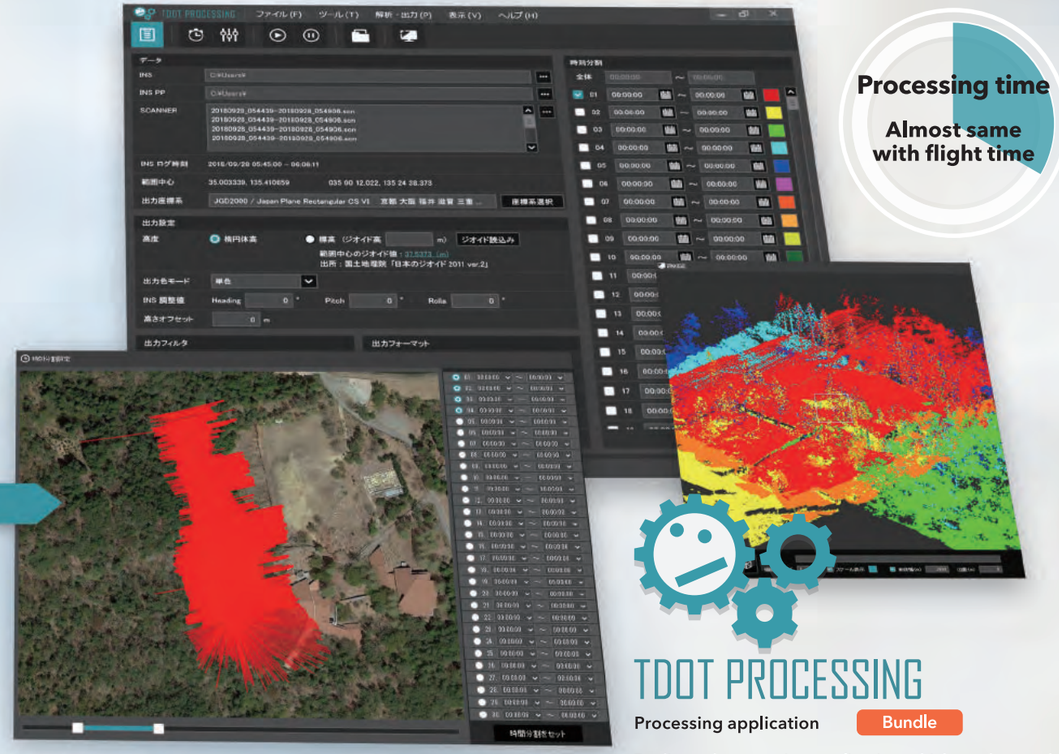
Automation of optimal baseline analysis for accuracy improvement

For accuracy improvement, scanner position and attitude of data capturing are necessary for high precise optimal baseline analysis.
Normally, expensive software and expertise knowledge are necessary for optimal baseline analysis.
Provided cloud service use reference station which interspersed, and make an optimal baseline analysis by uploading data automatically.

* Not only GNSS receiver data but also reference station data can be used as Ground station data.

Output the data speedy which is necessary for work

By importing optimal baseline analysis data which processed by cloud service to designated application, point cloud data of target range can output to various format.



Processing time

Almost same with flight time

3 Data output

Able to output precision point cloud data by processing optimal baseline analysis data and captured data.

TDOT PROCESSING

Processing application

Bundle

Dedicated processing application which can be used and operated intuitively.

Main Function

3D point cloud data analysis / Coordinates offset / Fine adjustment of attitude information / Display of captured data (dots & lines) / Coloring to point clouds using orthophoto / Coloring point of quality information / Correspondence of various coordinates systems (UTM etc.) / Output of accuracy control table / 3D point cloud output in various format etc..

TDOT
- GREEN -
DRONE LIDAR SYSTEM

From forest to river, and to coast
Green LiDAR system for various topographical survey

Compared to near-infrared wavelength, green wavelength is less absorbed at the water surface
(more reliable water surface reflections).
TDOT GREEN inherited the performance of TDOT PLUS as it is, and widen the scan range to topography under the water.
Green LiDAR system TDOT GREEN opens up a new world of survey.

Coast	River	Wet ground	Asphalt	Under vegetation
OK	OK	OK	OK	OK

Image of mounting to DJI Matrice 600 Pro

TDOT GREEN GALLERY

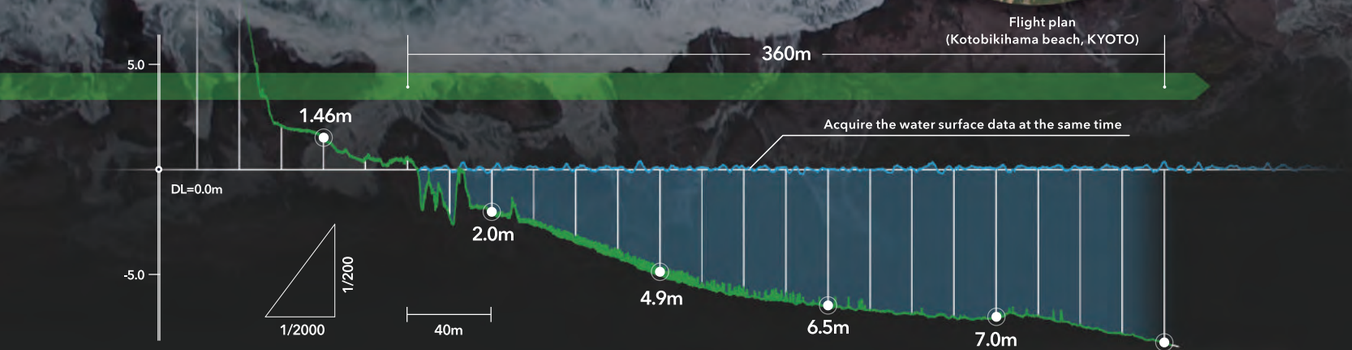
TDOT GREEN captured point cloud data

EXAMPLES OF SEA

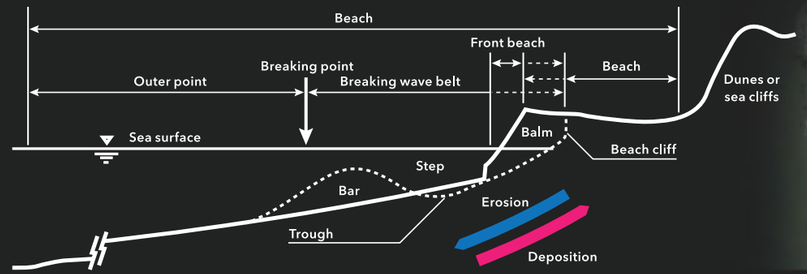
Bottom of the ocean at offshore 400m

- Acquire the data on both the water surface and the bottom of the ocean.
- Offshore 400m, deepest about 9m.

Flight plan
(Kotobikihama beach, KYOTO)



People have been making great efforts to visualize shallow sea area.
TDOT GREEN finally realized visualization of detailed sea floor topography,
and it is expected to contribute to coast development and maintenance from now on.

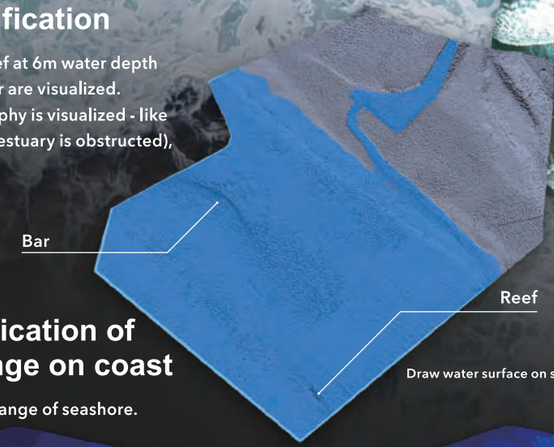


General seaside profile, its classification and representative topography (Sunamura, 1999)

Topography in the vicinity of influent river, stream bed, and shoreline.

Surface scan verification

- Sea area: The underwater reef at 6m water depth and the shape of the sand bar are visualized.
- Land area : The step topography is visualized - like the river meandering (as the estuary is obstructed), stream beds, and shorelines.

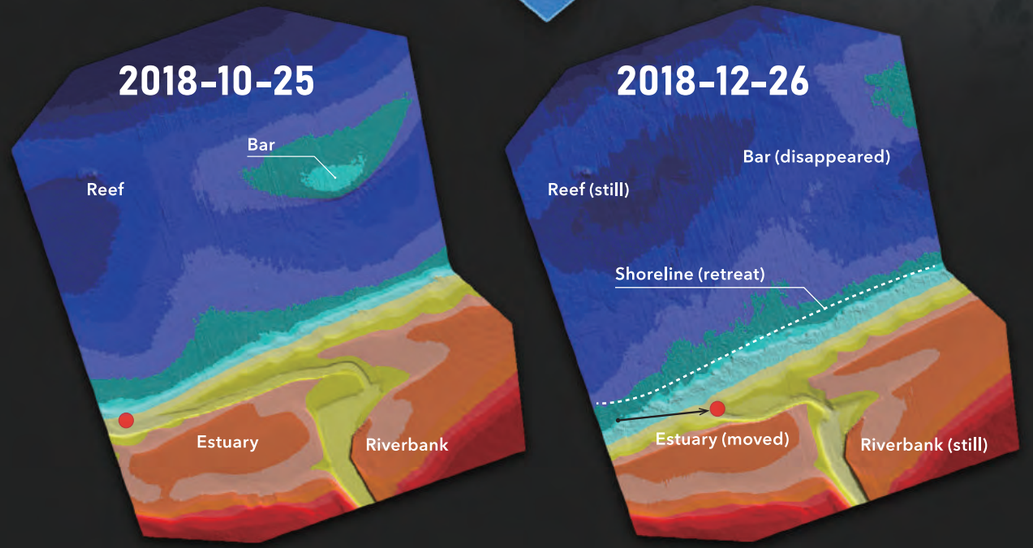


Draw water surface on shaded figure

Flight plan

Comparison verification of topographic change on coast

- Confirm fluid topographic change of seashore.



TDOT GREEN GALLERY

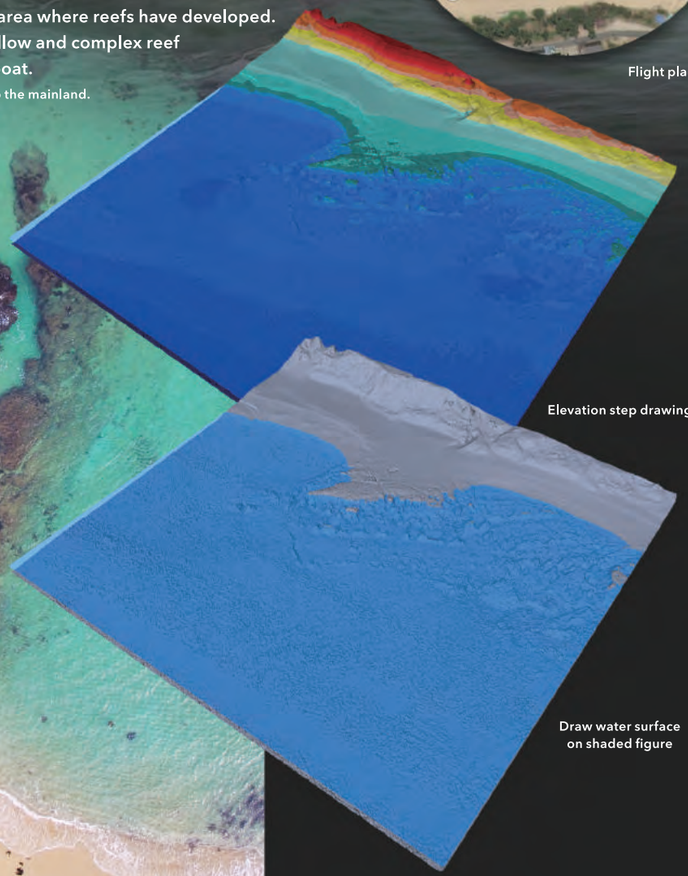
TDOT GREEN captured point cloud data

Micro-topographical validation in rocky or tongue-shaped sandbars(tombolo).

- Confirm the sea floor topography(bathymetry) of the water developed and formed by tombolo.
- Tombolo at offshore 150m
- Confirm the sea floor topography of an area where reefs have developed.
- Visualized the micro-topography of shallow and complex reef in areas where it is hard to survey with boat.

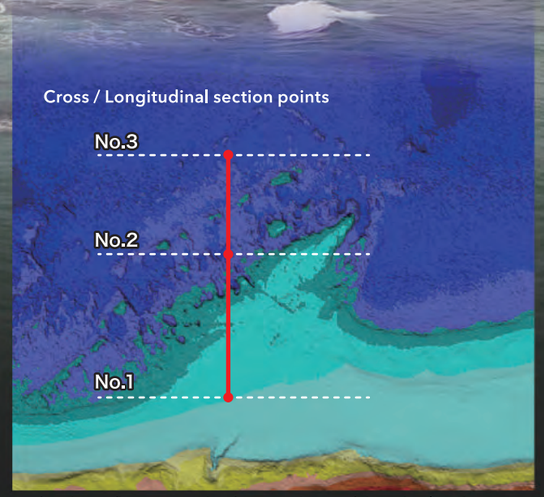
*Tombolo : a sand spit or sand bar connects an island to the mainland.

Flight plan



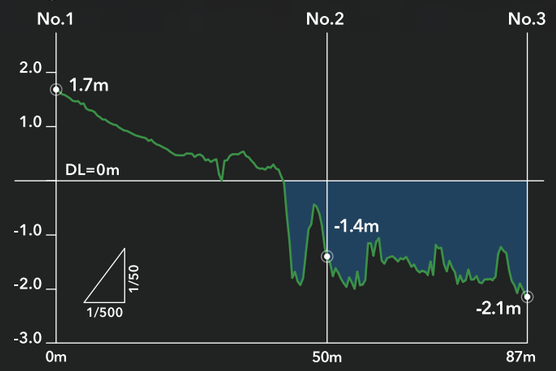
Elevation step drawing

Draw water surface on shaded figure



Confirm the sea floor topography of an area where reefs have developed.

Longitudinal section



Cross section

TDOT GREEN GALLERY

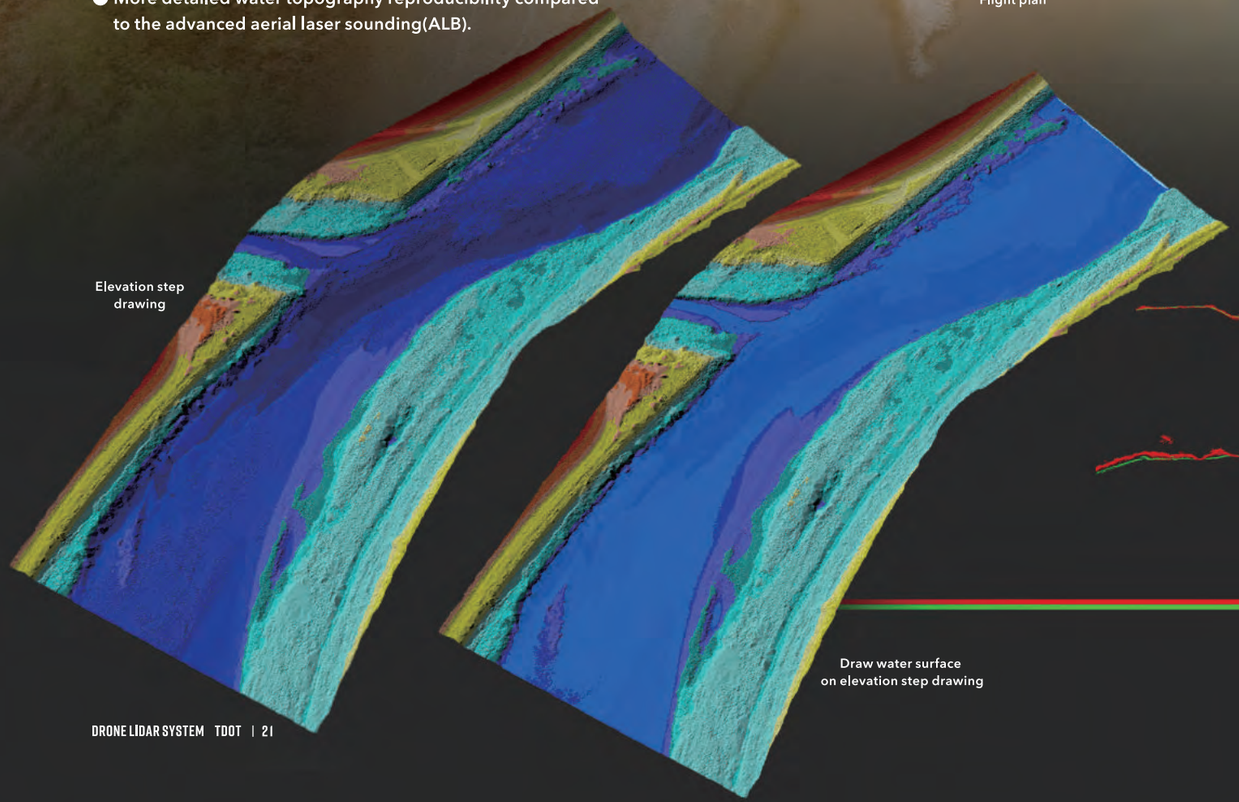
TDOT GREEN captured point cloud data

EXAMPLES OF RIVERS

Confirm the river channel topography within the river area.

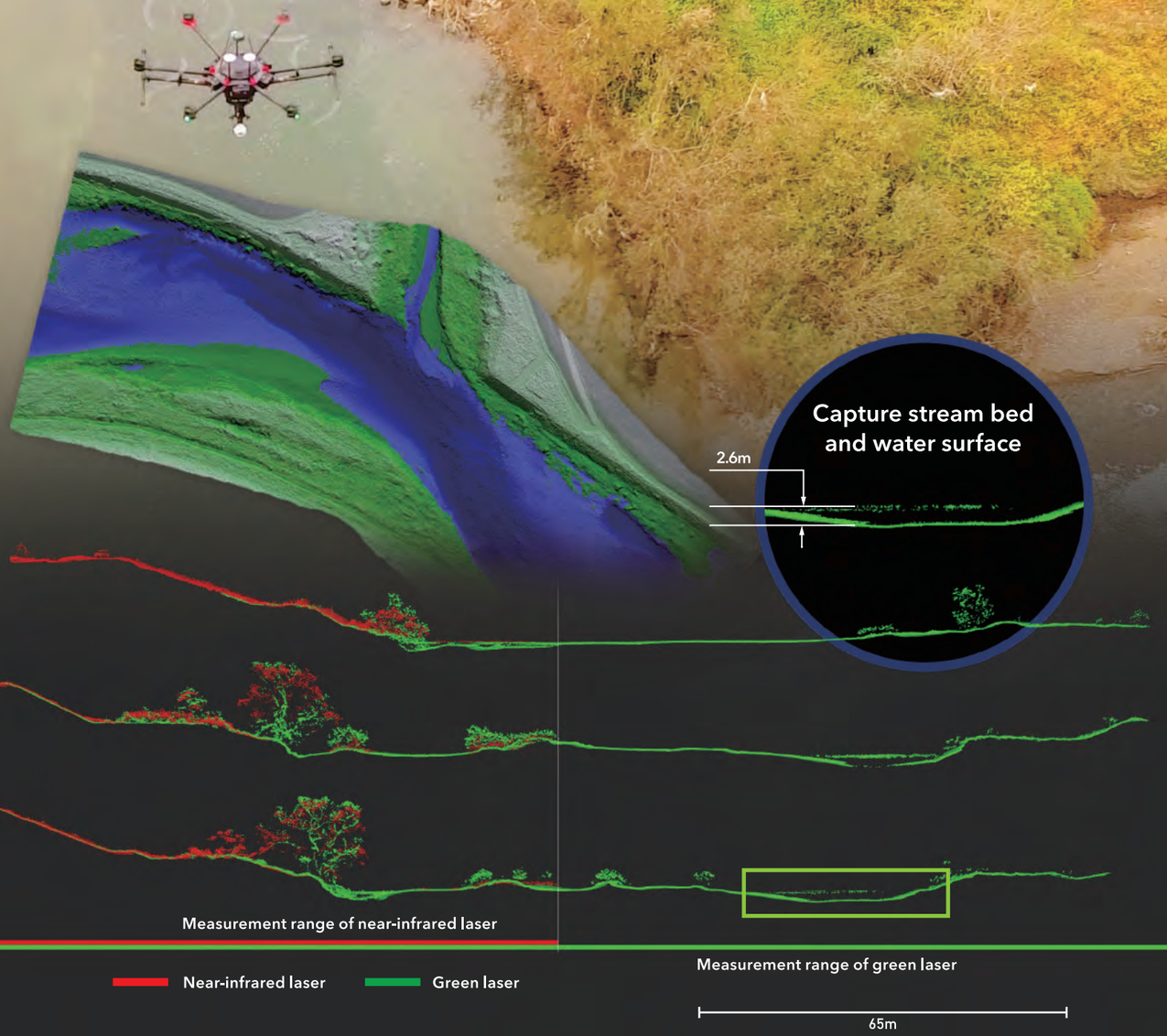
- Measure both land / water area in river channel at the same time.
- More detailed water topography reproducibility compared to the advanced aerial laser sounding(ALB).

Flight plan



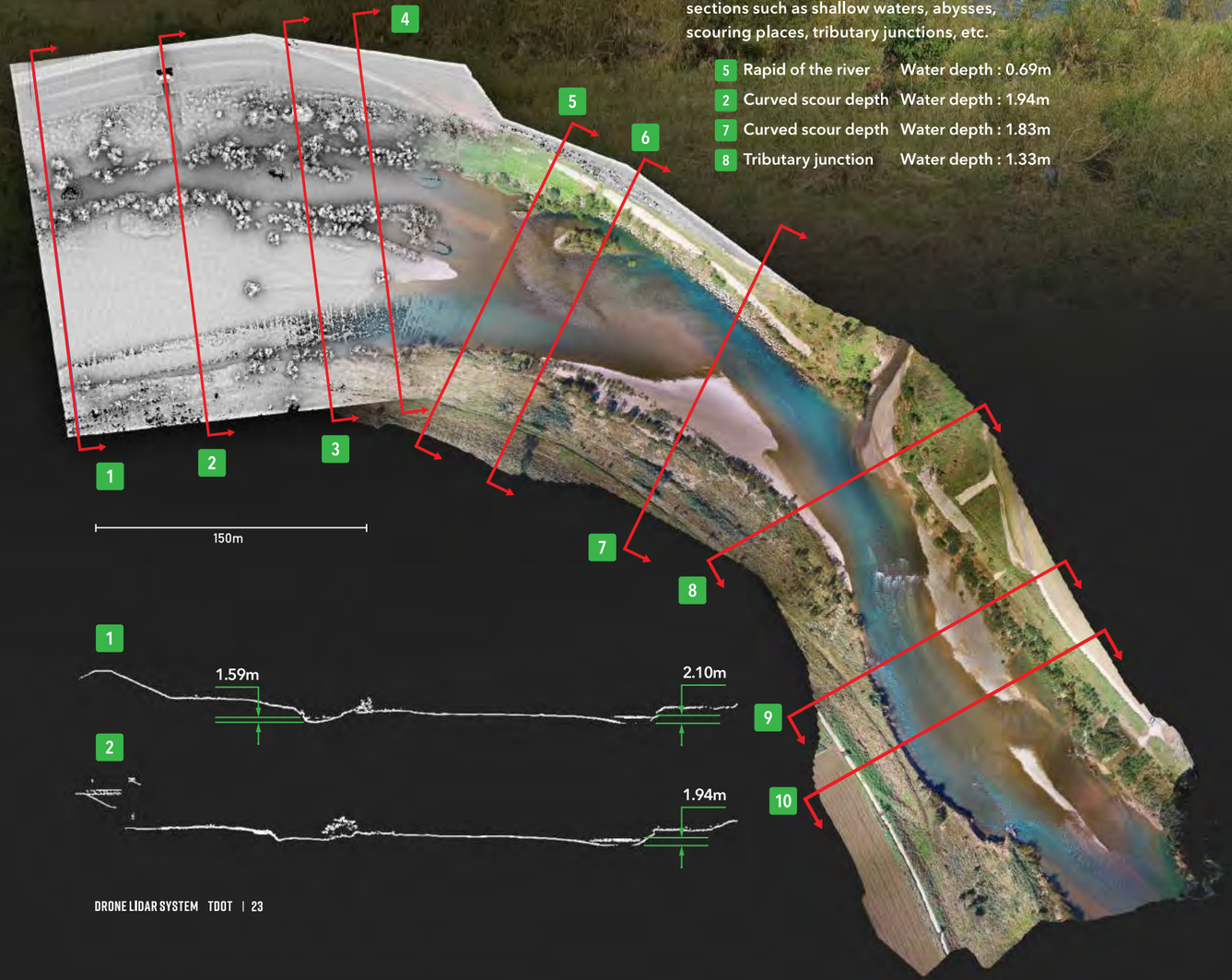
Elevation step drawing

Draw water surface on elevation step drawing



TDOT GREEN GALLERY

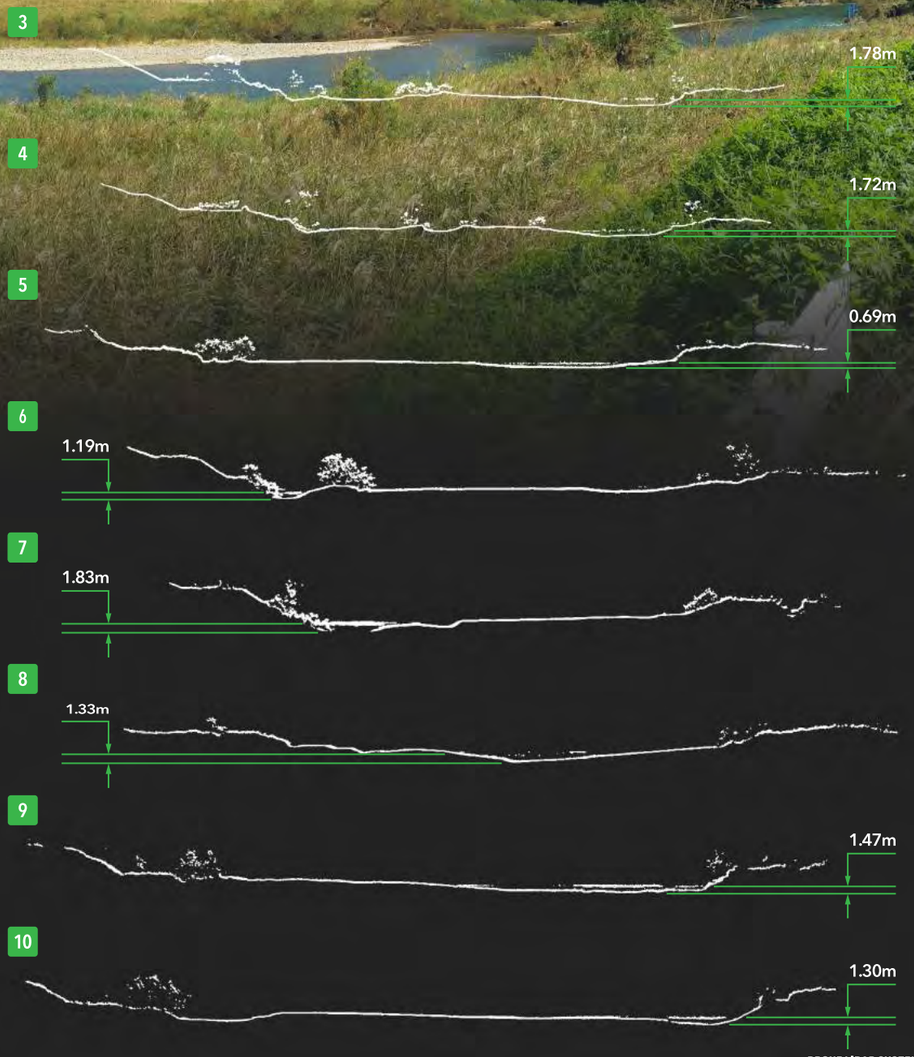
TDOT GREEN captured point cloud data



Bathymetric survey in the river area

- Confirm the water bottom topography in various sections such as shallow waters, abysses, scouring places, tributary junctions, etc.

5	Rapid of the river	Water depth : 0.69m
2	Curved scour depth	Water depth : 1.94m
7	Curved scour depth	Water depth : 1.83m
8	Tributary junction	Water depth : 1.33m



TDOT GREEN GALLERY

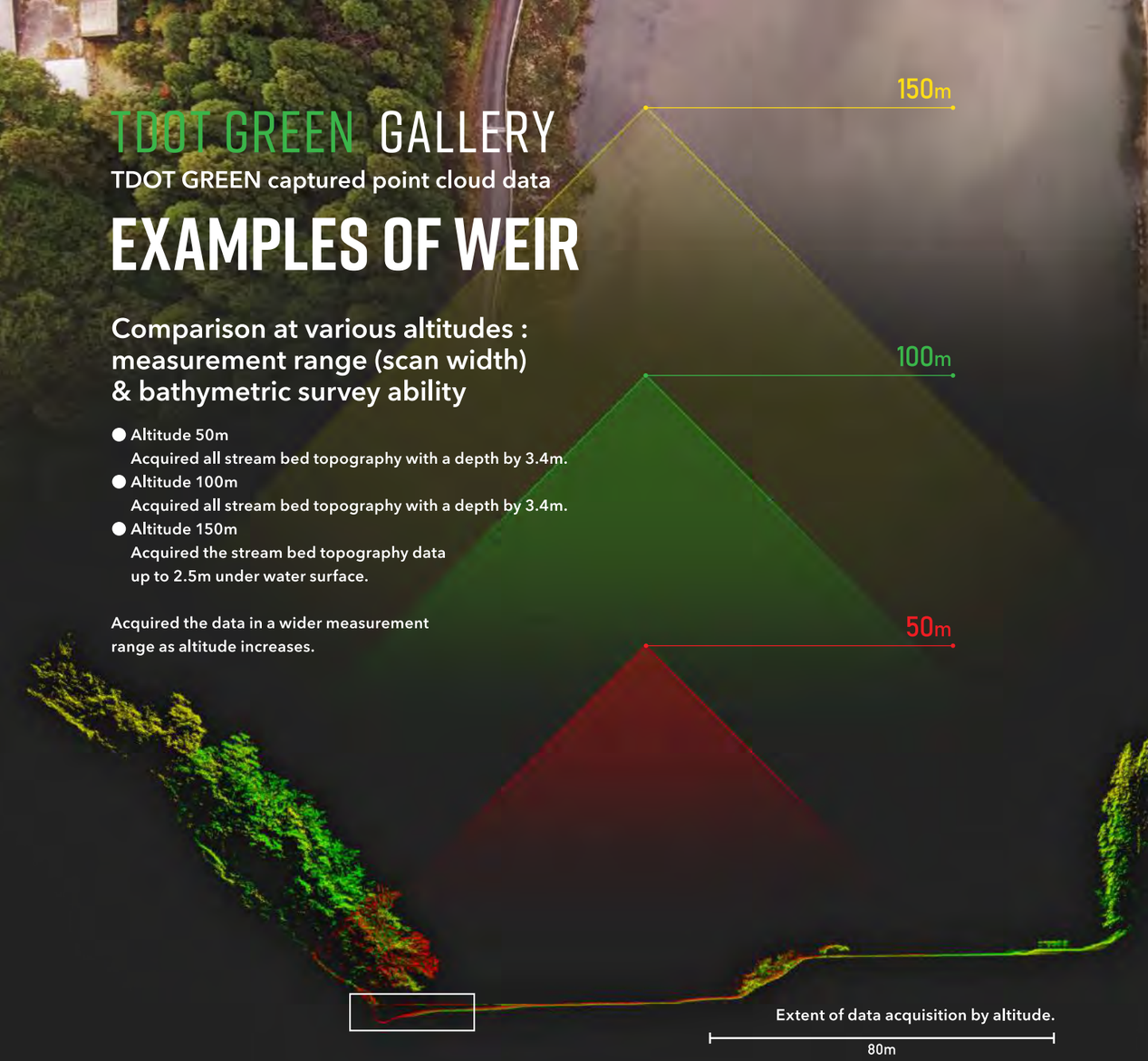
TDOT GREEN captured point cloud data

EXAMPLES OF WEIR

Comparison at various altitudes : measurement range (scan width) & bathymetric survey ability

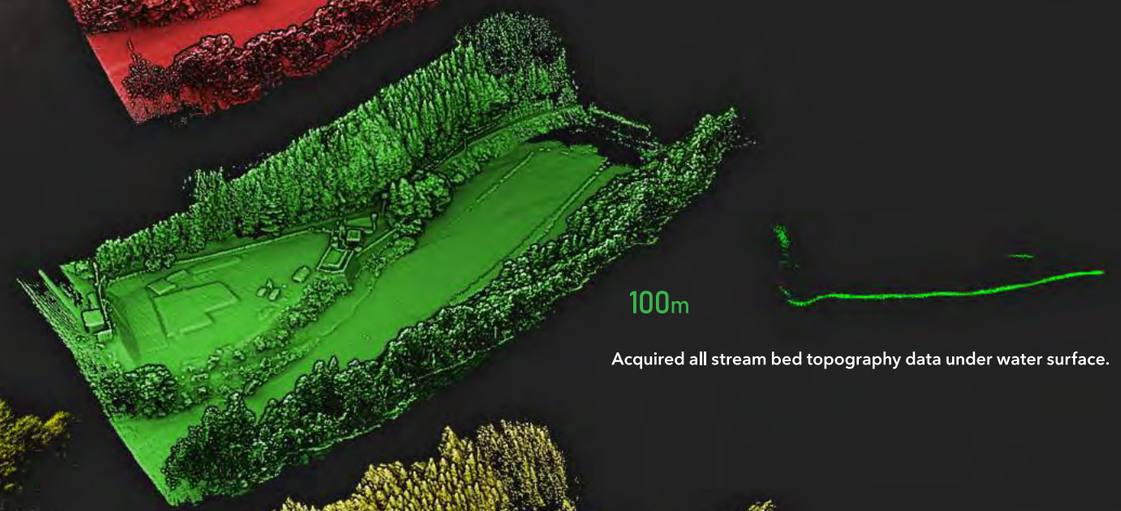
- Altitude 50m
  Acquired all stream bed topography with a depth by 3.4m.
- Altitude 100m
  Acquired all stream bed topography with a depth by 3.4m.
- Altitude 150m
  Acquired the stream bed topography data up to 2.5m under water surface.

Acquired the data in a wider measurement range as altitude increases.

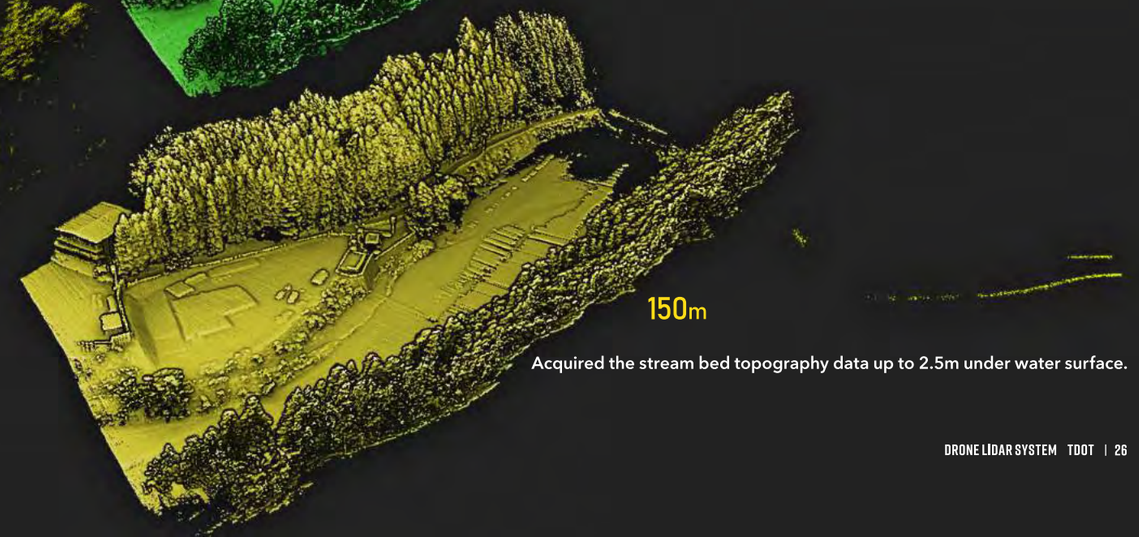


Enlarged sectional view of river part

Acquired all stream bed topography data and water surface.



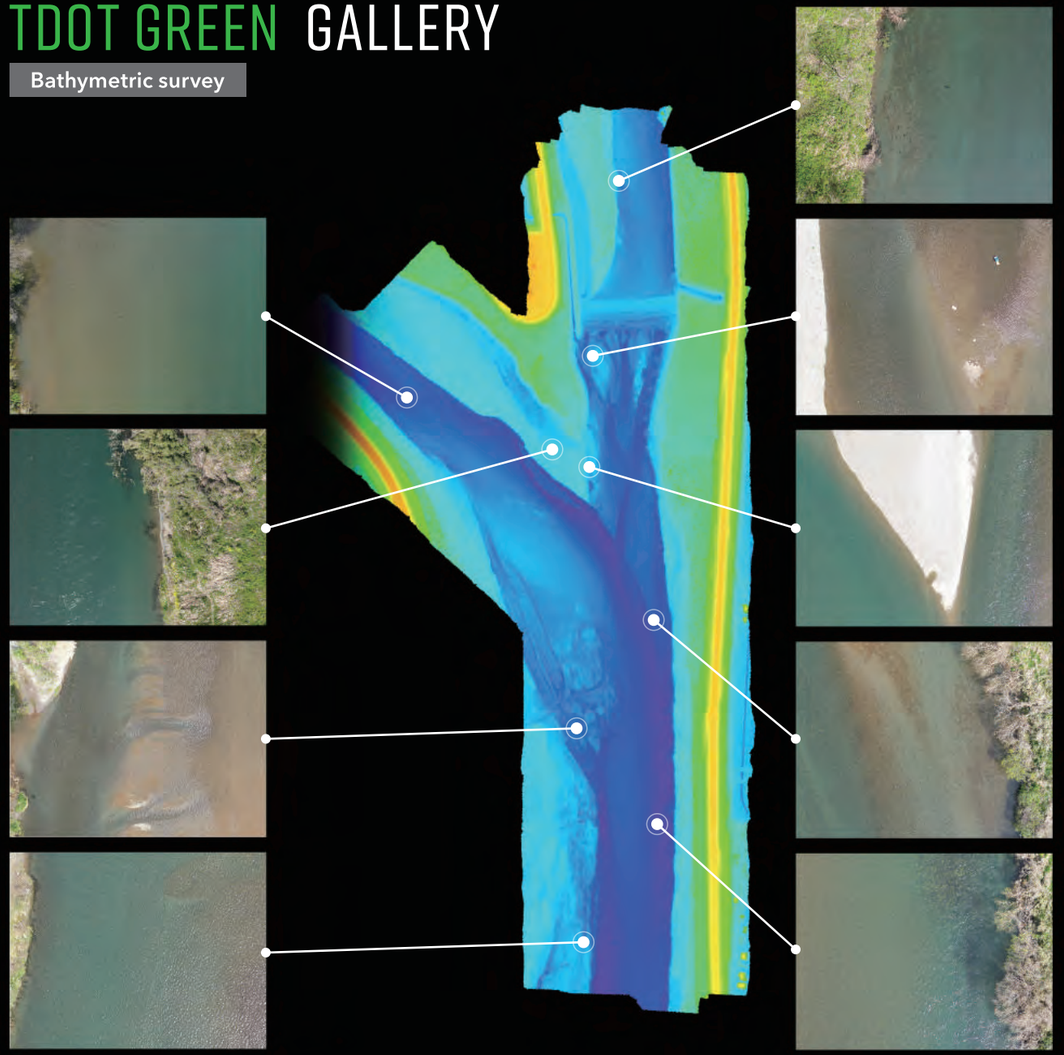
Acquired all stream bed topography data under water surface.



Acquired the stream bed topography data up to 2.5m under water surface.

TDOT GREEN GALLERY

Bathymetric survey



TDOT GREEN SPEC

TDOT GREEN Specifications

SPEC

Product name	TDOT GREEN
Size	W260 × D220 × H150mm
Weight	2.6kg (only main body)

LASER SCANNER SPEC

Maximum distance	≧10%	158m
	≧60%	300m over
Accuracy	≧10%	±15mm
	≧60%	±5mm
Laser pulse rate	60,000Hz / sec.	
FOV (field of view)	90°(±45°)	
Echo switching	1st / Last / 1st&Last / 4echoes	
Scan speed	30 scanning / sec.	
Laser wavelength	532 ± 1nm	
Beam divergence angle	1.0mrad	
Temperature	0 ～ +40℃	
Lifespan	10,000 hours	

INS SPEC *1

Horizontal accuracy	±10mm	
Height accuracy	±20mm	
Angular accuracy	Yaw	±0.02°
Attitude accuracy	Pitch / Roll	±0.01°

Eye safe function

It has an eye safe function to limit laser output at the altitude to ground. Complies with laser class1M.

- Ground altitude < 40m : class 1
- Ground altitude > 40m : class 3R(NOHD*2 : < 40m)

Bathymetric survey limit

at Altitude 50m from water surface

- R=1.0 , Absorption coefficient = 0.25(1/m) > 1.4 secchi *3
- R=0.5 , Absorption coefficient=0.25(1/m) > 1.25 secchi
- R=0.2 , Absorption coefficient=0.25(1/m) > 1 secchi

PACKAGE

- Green laser LiDAR system “TDOT GREEN”
- Dedicated GNSS antenna
- Alignment flight checker
- Mobile Battery
- Designated carrying case
- Pre-checking application "TDOT Pre PROCESSING"
- Processing application "TDOT PROCESSING" *4
- Application software "UNDERWATER CORRECT"
- Manual

OPTION

- TDOT mount adapter (for DJI MATRICE600 Pro)
- GNSS antenna stay (for DJI MATRICE600 Pro)
- Mass point cloud management application "3D-BASE PRO -amuse oneself edition-"

*1 : INS spec is improved accuracy after processed by "TDOT POST-PROCESSING CLOUD".

*2 : NOHD: Nominal Ocular Hazard Distance This is the distance from the laser source at which the intensity or the energy per surface unit becomes lower than the Maximum Permissible Exposure (MPE) on the cornea and on the skin. The laser beam can thus be considered as dangerous if the operator is closer from the source than the NOHD.

*3 : 1secchi = The depth at which the Secchi disk(a plain white disk 30cm in diameter to measure water transparency) is no longer visible.

*4 : It's necessary to have separate contract in order to use online processing service " POST-PROCESSING CLOUD".

TDOT
- PLUS -
DRONE LIDAR SYSTEM

Proven ability achieved requirement accuracy of "i-Construction (ICT engineering work)" class.

TDOT is UAV LiDAR which achieved requirement accuracy ±50mm of ICT engineering
in "Innovative River Management Project" held by MLIT.
1.8kg lightweight body enable long flight.
27 minutes flight time when mount by DJI Matrice600 Pro.

* MLIT : Ministry of Land, Infrastructure, Transport and Tourism

Result of "Innovative River Management Project Topographic / Bathymetric LiDAR" held by MLIT.

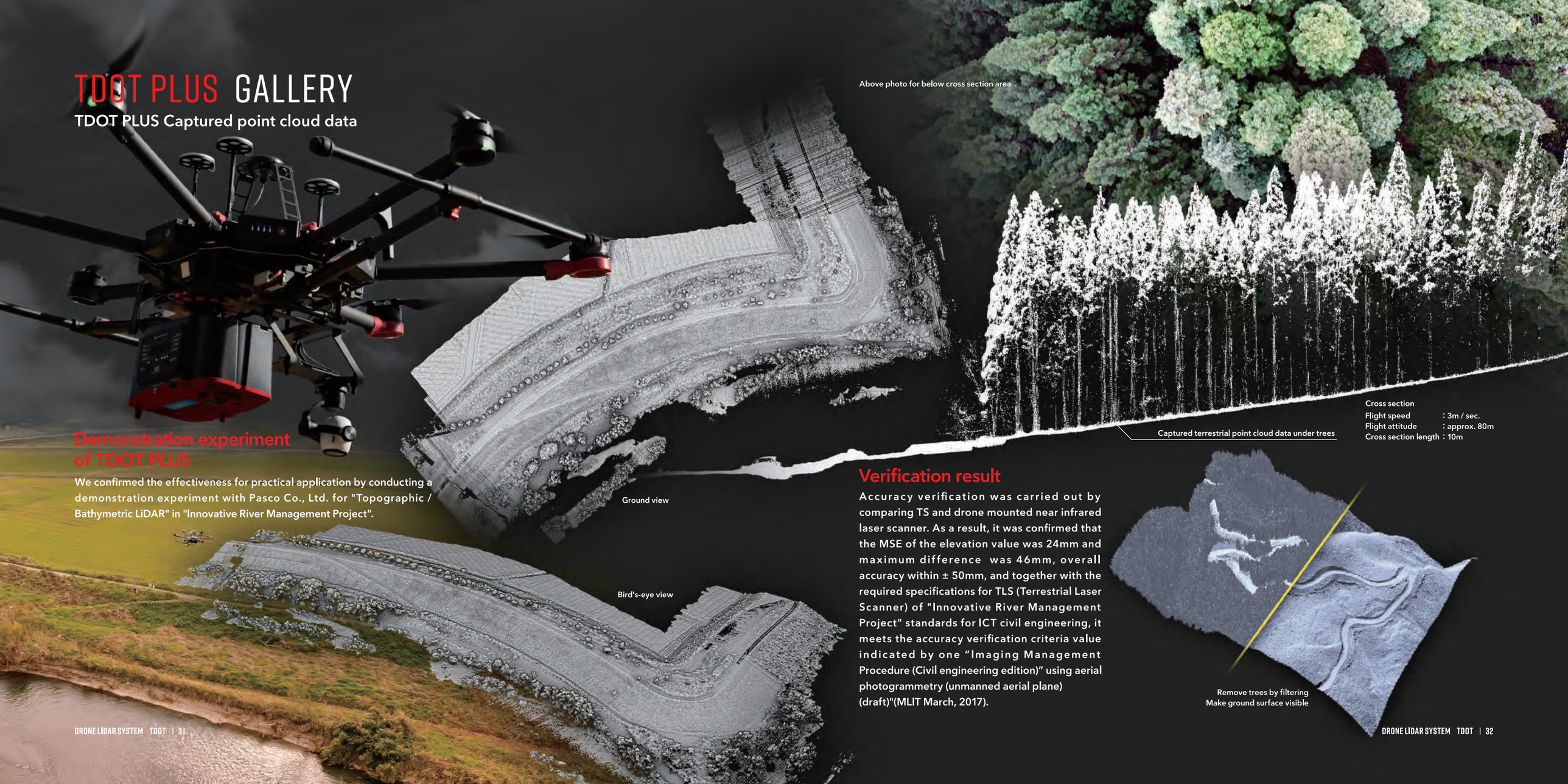
Validation Point	> 12 points	Measuring condition	> Altitude : 50m, Speed : 2.0m/s
Average value	> 0.010 m	Maximum difference (Disparity)	> -0.046 m
Average deviation	> 0.022 m	Mean square error	> 0.024 m

* Researched by PASCO Corporation.

Image of mounting to DJI Matrice600 Pro

TDOT PLUS GALLERY

TDOT PLUS Captured point cloud data



Above photo for below cross section area

Captured terrestrial point cloud data under trees

Cross section
Flight speed : 3m / sec.
Flight attitude : approx. 80m
Cross section length : 10m

Ground view

Bird's-eye view

Demonstration experiment of TDOT PLUS

We confirmed the effectiveness for practical application by conducting a demonstration experiment with Pasco Co., Ltd. for "Topographic / Bathymetric LiDAR" in "Innovative River Management Project".

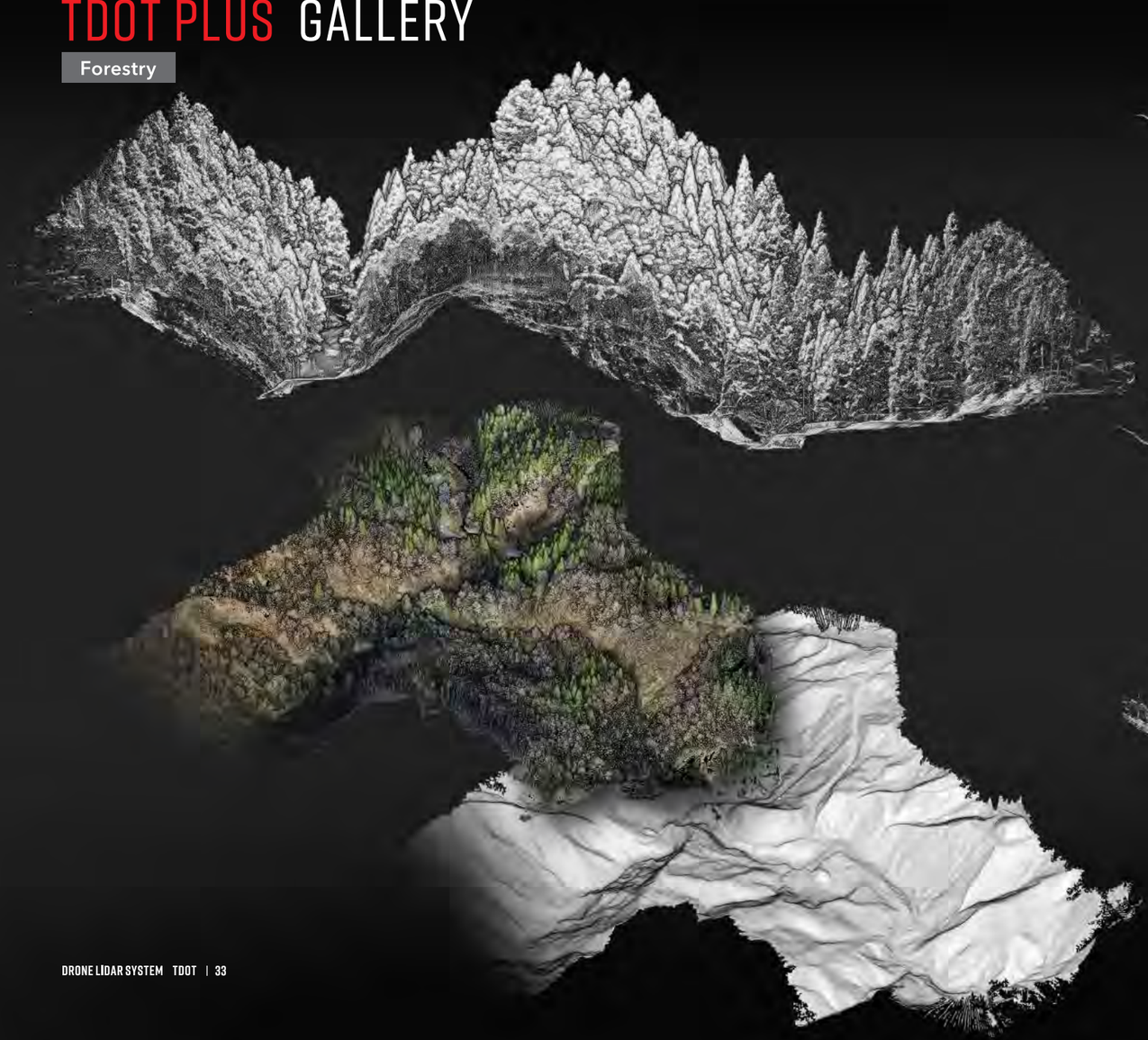
Verification result

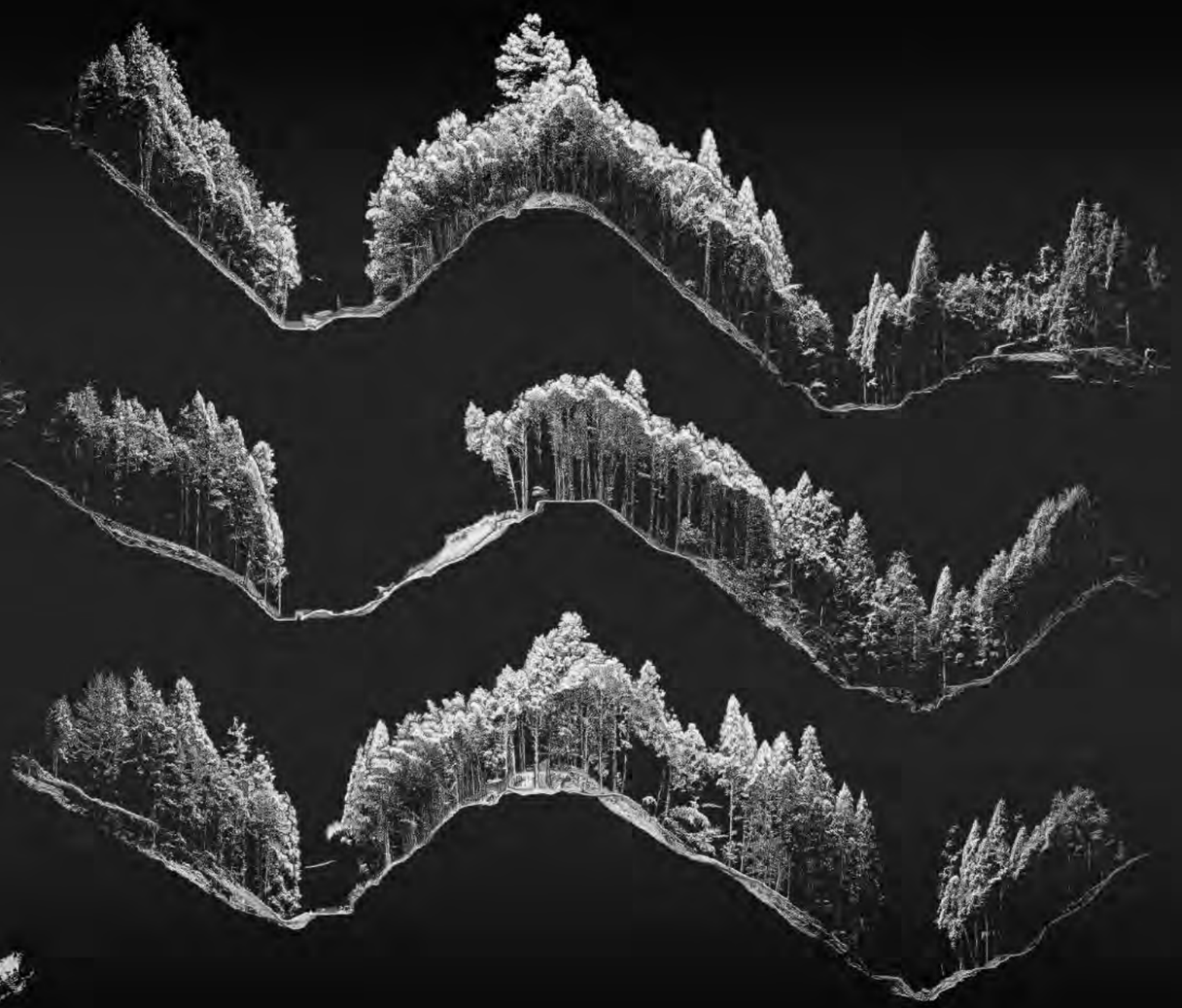
Accuracy verification was carried out by comparing TS and drone mounted near infrared laser scanner. As a result, it was confirmed that the MSE of the elevation value was 24mm and maximum difference was 46mm, overall accuracy within ± 50mm, and together with the required specifications for TLS (Terrestrial Laser Scanner) of "Innovative River Management Project" standards for ICT civil engineering, it meets the accuracy verification criteria value indicated by one "Imaging Management Procedure (Civil engineering edition)" using aerial photogrammetry (unmanned aerial plane) (draft)"(MLIT March, 2017).

Remove trees by filtering
Make ground surface visible

TDOT PLUS GALLERY

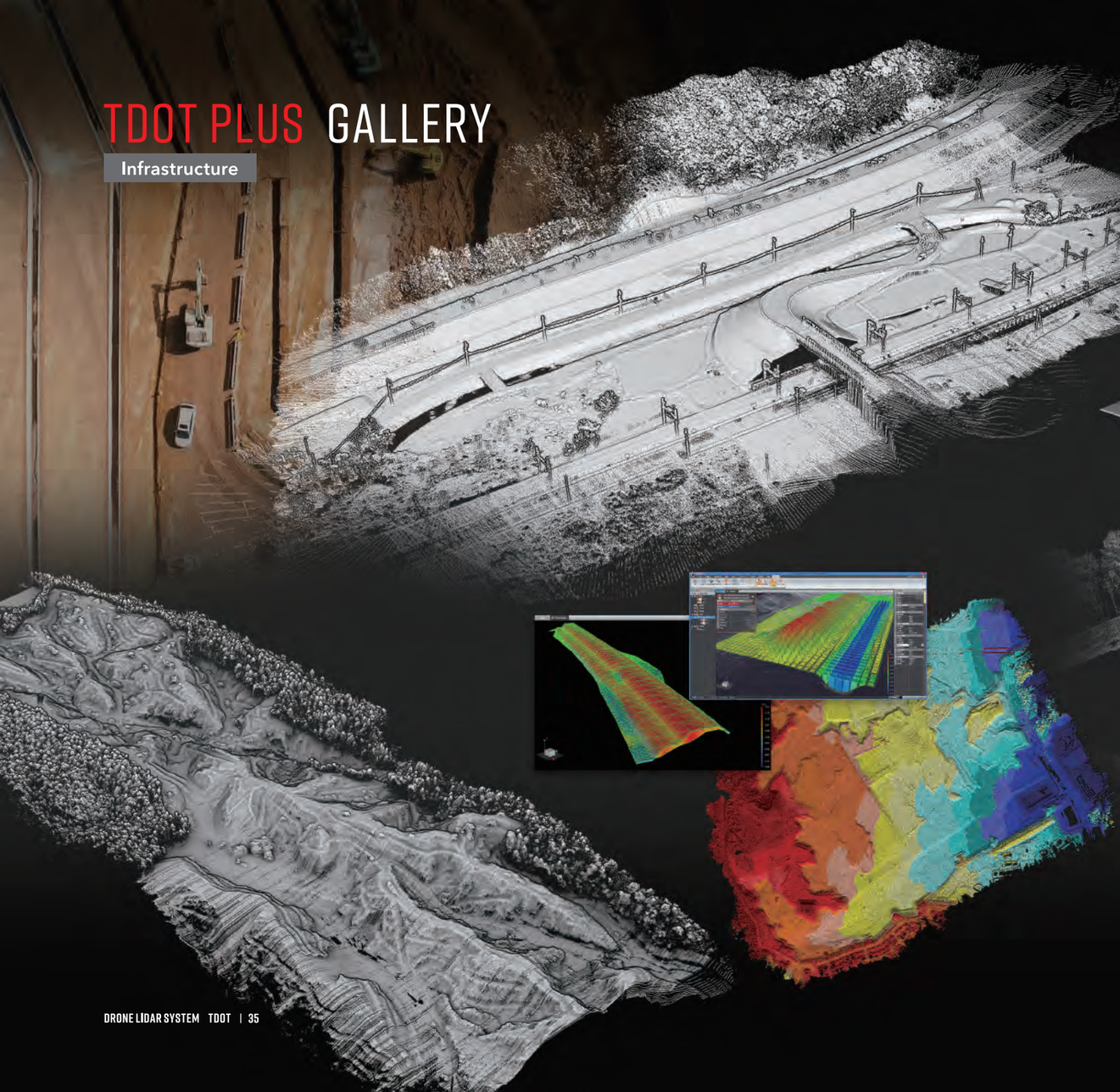
Forestry





TDOT PLUS GALLERY

Infrastructure



TDOT PLUS GALLERY

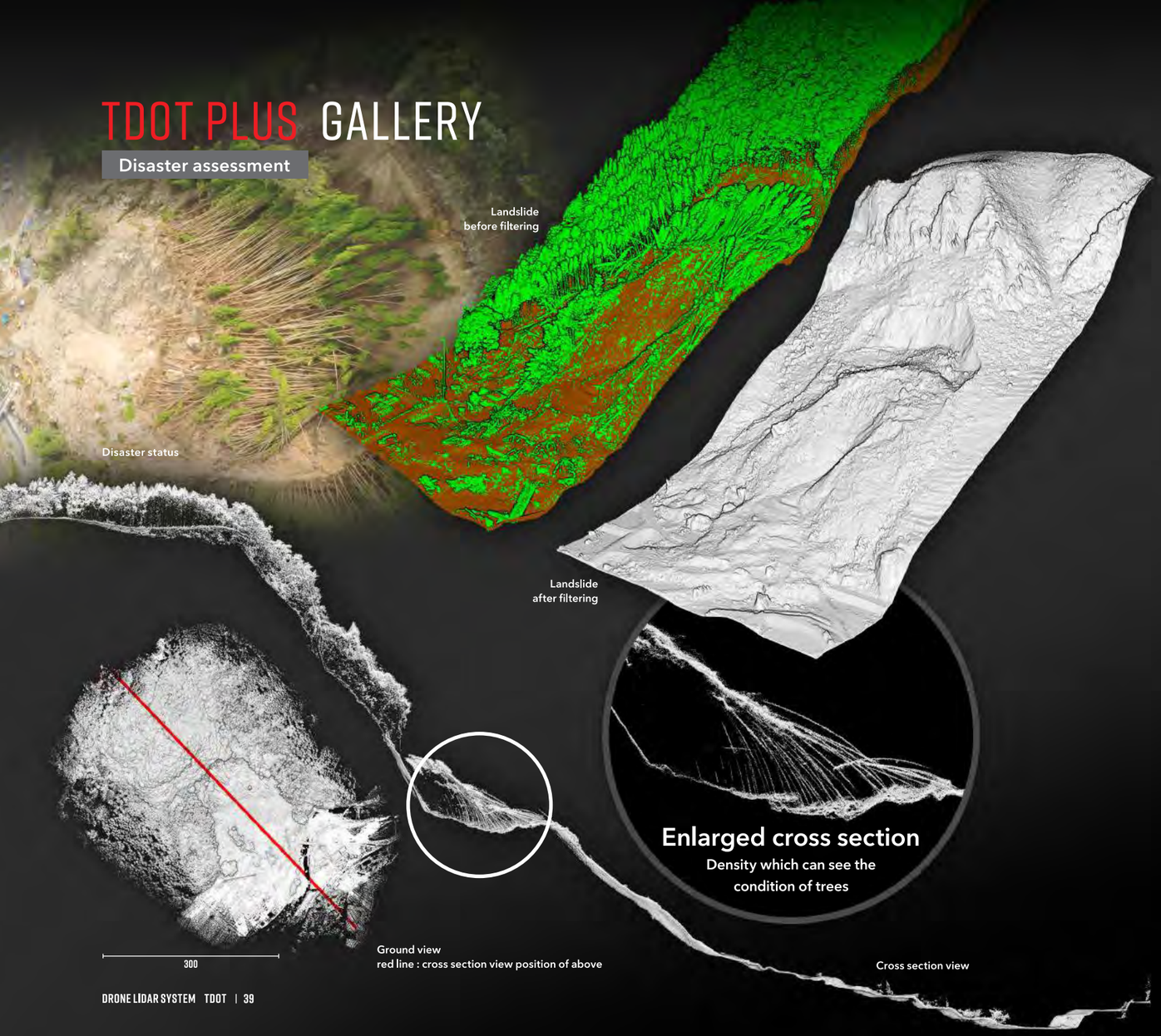
Disaster assessment

TDOT PLUS GALLERY

Investigation

TDOT PLUS GALLERY

Disaster assessment



TDOT PLUS SPEC

TDOT PLUS Specifications

SPEC

Product name	TDOT PLUS
Size	W260 × H186 × D150mm
Weight	1.8kg (only main body)

LASER SCANNER SPEC

Maximum distance	≧30% ～ 200m over
Accuracy (1σ)	±4mm @ 50m
	±20mm @ 150m
Laser pulse rate	60,000Hz /sec.
FOV (field of view)	90° (±45°)
Echo switching	1st / Last / 1st&Last / 4echoes
Scan speed	30 scanning / sec.
Laser wavelength	905 ± 1nm
Beam divergence angle	1.0mrad
Laser class	Class 1M
Temperature	0 ～ +40℃
Lifespan	10,000 hours

INS SPEC *1

Horizontal accuracy	±10mm	
Height accuracy	±20mm	
Angular accuracy	Yaw	±0.02°
Attitude accuracy	Pitch / Roll	±0.01°

PACKAGE

- Near-infrared LiDAR system "TDOT PLUS"
- Dedicated GNSS antenna
- Alignment flight checker
- Mobile Battery
- Designated carrying case
- Pre-checking application "TDOT Pre PROCESSING"
- Processing application "TDOT PROCESSING" *2
- Manual

OPTION

- TDOT mount adapter (for DJI MATRICE600 Pro)
- GNSS antenna stay (for DJI MATRICE600 Pro)
- Mass point cloud management application "3D-BASE PRO -amuse oneself edition-"

*1 : INS spec is improved accuracy after processed by "TDOT POST-PROCESSING CLOUD".
*2 : It's necessary to have separate contract in order to use online processing service " POST-PROCESSING CLOUD".

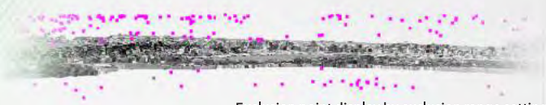
APPLICATION

Bundle

UNDERWATER CORRECT

Underwater correct system

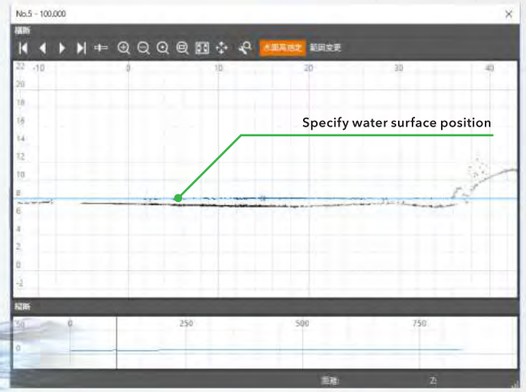
Biggest feature of TDOT GREEN is underwater measurement by laser without being absorbed.
Laser refract at water surface.
Newly developed underwater correct system.



Exclusion point display by exclusion range setting

1 Remove noise by specifying range

Open the point cloud data of refraction processing, and remove noise by exclusion range setting



Specify water surface position

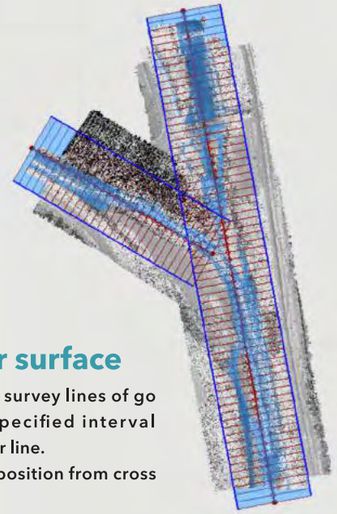
Vertical specification

2 Specify main river and branch river

Specify main river and branch river by drawing center line at river channel.

3 Specify water surface

Automatic generation survey lines of go through river with specified interval against specified center line.
Specify water surface position from cross section.

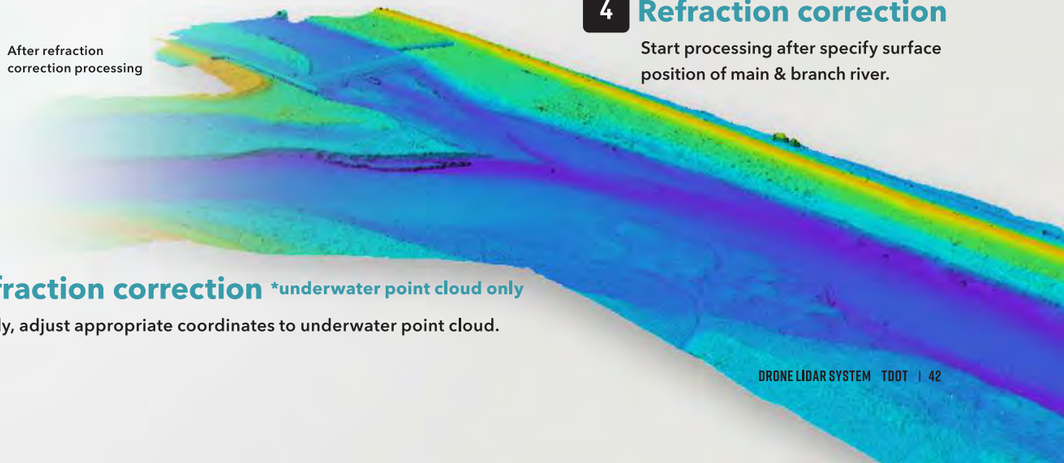


Complete specifying water surface position

4 Refraction correction

Start processing after specify surface position of main & branch river.

After refraction correction processing



5 Refraction correction *underwater point cloud only

Finally, adjust appropriate coordinates to underwater point cloud.

APPLICATION

Option

3D-BASE PRO

AMUSE ONESELF EDITION

Microsoft® Windows10 / 8 / 8.1 / 7 (64bit)

Powered by Mirai System Factory

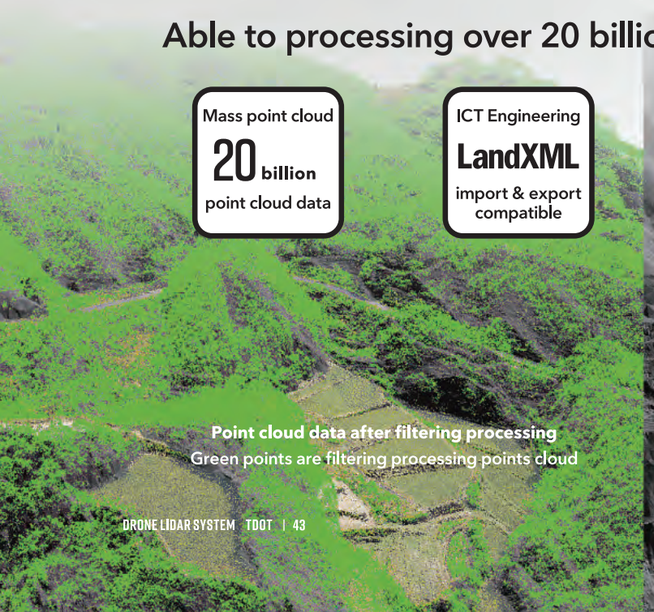
Able to processing over 20 billion point cloud data application

Mass point cloud
20 billion
point cloud data

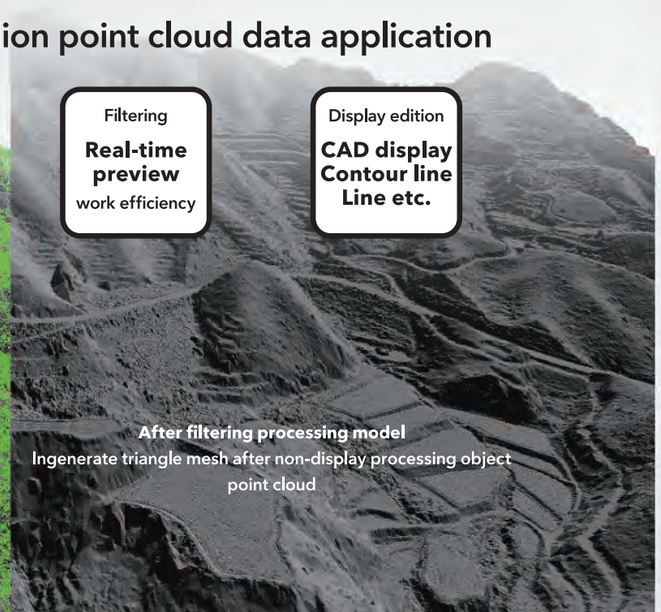
ICT Engineering
LandXML
import & export compatible

Filtering
Real-time preview
work efficiency

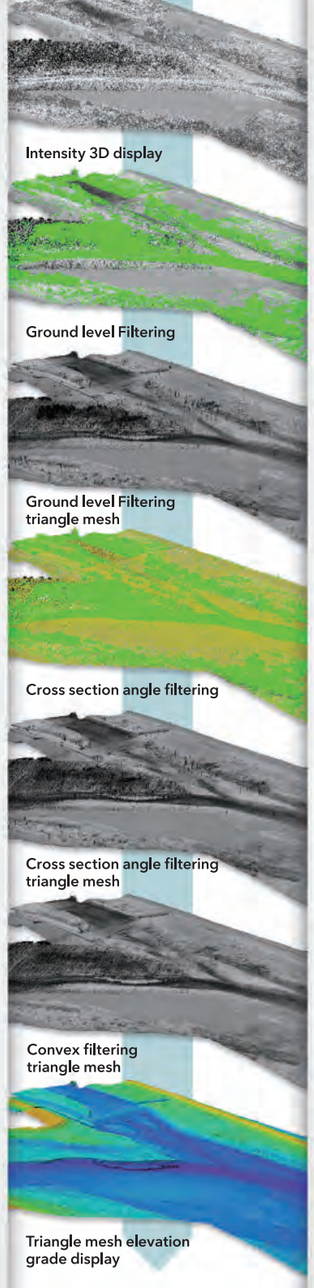
Display edition
CAD display Contour line Line etc.



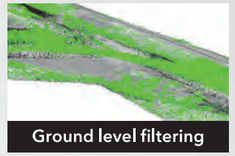
Point cloud data after filtering processing
Green points are filtering processing points cloud



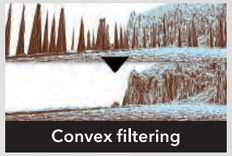
After filtering processing model
Ingenerate triangle mesh after non-display processing object point cloud



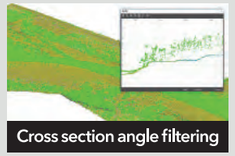
Filtering function



Ground level filtering



Convex filtering



Cross section angle filtering

- **Ground level filtering**
  Remain low elevation point data and remove high elevation point data
- **Convex filtering**
  Filtering by using slope of triangle mesh
- **Noise remove filtering**
  Automatic detection the noise and remove
- **Cross section angle filtering**
  Specify cross section angle and remove unmatching points
- **Building filtering**
  Remove artificial structure such as buildings
- **Bottom of the sea filtering**
  Remain high elevation point & remove other points
- **Thinning filtering**
  Specify range and choose one point, and remove other points
- **Approximate point filtering**
  Remove approx point as recognize as same point
- **Height difference filtering**
  Specify height difference and remove unmatching points
- **Regression point filtering**
  Tilt steep slope area as flat, and execute ground level filtering

Function introduction

Preview function

Layer function

- **Filtering preview**
  Preview processed condition before filtering
- **Layer function**
  Auto-generation layer function per processing
- **CAD data import**
  Able to display CAD data at background
- **Import coordinates**
  poi / txt / csv / las / e57 / xml / mpoi / mpcd
- **Export coordinates**
  poi / txt / las / e57 / bos2
- **Ingenerate triangle mesh**
  Able to ingenerate to over multi-billion point cloud data
- **Triangle polygon**
  Import & export LandXML data
- **Line**
  Import & export Linear SIMA data Vertical crossing data edit function, export vertical crossing SIMA data
- **Ingenerate square mesh**
  Able to soil volume calculation by layer comparison
- **Display function**
  2D / 3D / bird's-eye / Ortho / Cross section
- **Contour line**
  Contour line generate / delete / export (dwg/dxf)
- **Color point cloud**
  Able to add color information to coordinates which same position with ortho photo
- **Measurement (two point / range)**
  Two point measurement : start & end point XY / distance / diagonal distance / slope / △XYZ
  Range measurement : area / perimeter / △XY

APPLICATION

Option

FLIGHT PLAN BUILDER

Flight plan along terrain will be automatically generated by specifying range after selecting flight type.

Automatically generate flight plan which secured setting clearance by specifying flight area by touch operation. Easy to create complex flight plan such as alignment flight.

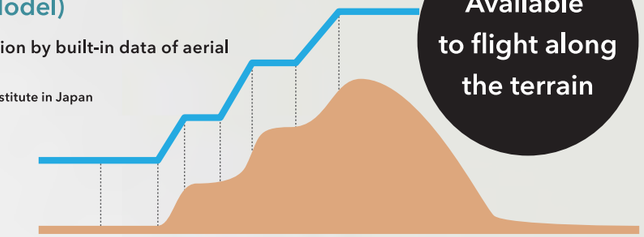
* It's only available to laptop which has touch operation. Of course, mouse operation is available.

FLIGHT PLAN BUILDER
(Windows)

Built-in data of aerial photograph of Japan nationwide and DEM data (Digital Elevation Model)

Available to create flight plan even offline condition by built-in data of aerial photograph of Japan nationwide and DEM data.

*It's necessary to apply for use the data to Geographical Survey Institute in Japan



Available to flight along the terrain

Control DJI drone by FLIGHT PLAN BUILDER iOS version

Available to send flight plan to DJI drones by synchronizing flight plan from Windows to iOS version FIGHT PLAN BUILDER.
Camera control is also available, and easy to operate whole flight plan by this application.

EXPORT > IMPORT

FLIGHT PLAN BUILDER
(iOS)

*Note : Availability of using this application depends on each countries.

Available to display map even offline condition

DEVELOPER'S PHILOSOPHY

Japan is vulnerable to many forms of natural disasters and in 2018 several typhoons caused large-scale damage across the country. When these disasters occur, it is common to survey the damage using manned aircraft such as a cessna or helicopter. Forest areas, for example, can be assessed using aerial photography as well as techniques of aerial laser survey. As a specialist in this field I am experienced in the use of laser measurement, particularly from manned helicopters. Disasters are not only the result of massive events but smaller-scale landslides can take place and cause casualties. For these incidents it is too costly to measure the extent of damage with a manned helicopter.

So, I thought "drone", There are a number of advantages with drones: they are self-flying and provide real-time results. Technological progress is remarkable. I barely fly the current drone, pressing only one button from take-off to landing. It has become automatic flying. You can now take aerial shots safely after a short duration of training. Along with aerial photographs, easy-to-use laser systems are also required.

In 2013. we developed a drone-mounted laser and began to offer these services - including for sale. In operation, many customers have asked the impossible - tasks within and beyond expectations. As a customer this is natural, I've been working on finding solutions to these impossible expectations. Here are some specific examples.

First, a flight plan. During normal situations, you can make an advance plan with plenty of time. However, disaster response requires urgent action: going straight to the site; locating a takeoff and landing place; wondering if it will take off; not knowing the height difference of the target mountain. Also, in places where there is no internet environment the background imagery and data cannot displayed. Therefore, by collecting and saving aerial photographs and altitude data throughout the country to a PC database, we have created a system that automatically creates plans along the terrain by simply specifying the measurement range at the side.
In the field, I want to see the acquired data on the spot immediately. The confirmation of missing places is also necessary. Therefore, we have made the pre-analysis / point-group browsing possible in a few minutes after landing. The next stage is the analysis processing. Knowledge of surveying, such as complex optimal baseline analysis of GNSS and INS, is absolutely essential. Traditionally, professionals would analyze this for a long time using expensive applications. We have developed a programme, based on our experience, and stored it on the cloud. As a result, it is possible to fully perform the process, from collecting the electronic reference point data to the analysis process, thus freeing up time from the complicated work.

We have developed the world's first drone-mounted green laser scanner system. The focus of Green Laser has been in underwater scanning. However, I am expecting to use green laser to completely scan the black object and the wet road surface, which was previously impossible in near-red. Because the debris flow of a disaster location is often wet, the application of the green laser system immediately after the event can be an effective tool. Though real-time operability is a selling point of drones, a near-red laser cannot scan topography until the site has dried. However, with green laser, you can scan the site as it stops raining. If it is installed in an all-weather type drone, there is a possibility that it can be applied to the site of the disaster in real-time.

The drone-mounted lasers developed in near-red and green systems are lightest in class. They can be operated with a general drone of about 3kg payload - this can also be prepared as a rental item. This saves you the time and effort of transporting the drone over long distances. By reducing the drone's weight, the flight time can be extended thus reducing the number of flights per measurement area. More than anything, the margin of the flight time is the most appreciated factor on site since safety can be improved.

When talking about fine technology, the ability to fix and adjust a misalignment of the optical axis of the laser is important. It is also quite difficult if 3-dimensional thinking cannot be done. I have developed the GPU along with a tool that can be used to adjust, quickly and visually, any problems that occur. While this tool is not yet perfected we are aiming towards complete automation.

I will continue to develop hardware and software while listening to the voices of the site.

amuse oneself. Inc CTO
Takaharu Tomii

MESSAGE

“User First” and the development of new technology

Innovative River Projects required a three-dimensional surveying technique to enable seamless surveying of the land and underwater parts of rivers. In addition, the “open innovation” method was adopted in order to carry out on-site implementation with a sense of speed of about six months to one year or so.

In 2013, we developed the world’s first drone laser system and began selling it. Collaborating with the PASCO Corporation and participating in pitch events, we have been working on further technological improvements. As a result, we have succeeded in creating a drone-mounted near-infrared laser scanner, followed by a drone-mounted green laser that can simultaneously measure submerged areas.

From the beginning, we pursued a “user first” approach which aimed at an easy-to-use system incorporating the opinions of users. We have avoided merely importing and combining devices. Instead, we have consistently managed our own development from design to creation.

We recognize that the drone-mounted green laser system which can be used to scan underwater is a world-first innovation. With this system, it is now also possible to measure terrain / features that are wet from floodwater, which was previously impossible with near-infrared lasers. Furthermore, if installed on an all-weather type drone, it will be possible to grasp the situation of a river during floods. In addition, we have developed software for creating flight plans, onsite data confirmation, and user-friendly analysis processing at the same time. Thanks to these we are proud that we have built an epochal, three dimensional surveying system.

However, as a system yet to be tried in the field it is expected that there will be future problems not yet experienced. Our employees are not concerned by this because we are standing at the origin of a new technique and will continue to work hard and sincerely. We look forward to your continued support into the future.

amuse oneself.inc

President

Hikaru SANO

Aiming to expand the possibilities of state-of-the-art measurement technology

In April 2017, Pasco CO., Ltd. began work on developing a practical application for a “Land / Underwater Laser Drone” as part of the “Innovative River Management Project” conducted by the Ministry of Land, Infrastructure and Transport in partnership with Amuse Oneself. I am grateful to report that I was able to complete the mission safely and hereby express my appreciation to the many people who gave us their support.

Established in 1953 as an aeronautical surveying company, we have been working towards completely digitized aerial photogrammetry since around 2000. To achieve this we made full use of artificial satellites from 2005 and, in 2015, the aircraft laser sounding machine or ALB (Airborne Laser Bathymetry). We were the first private company in Japan to do so. Our aim is focused on the practical application of research to solve problems in society using the most advanced technology. A significant problem is climate change and the consequent increase of natural disasters. One example is the way short periods of intense, torrential rains are exceeding previous patterns causing rivers to flood and inflict severe damage. Therefore, it is important to maintain river channel conditions and keep river management facilities in good condition. This, along with applying other necessary measures promptly and in a manner appropriate to each particular situation.

Up to now, river management understood the state of rivers by performing monitoring programmes. This includes regular crossing-surveys conducted at about 200m intervals, along with daily patrols and inspections. Therefore, to improve river management, the establishment of a technique to acquire data on the state and condition of the riverbed via planar three-dimensional methods was required. The “Land / Underwater Laser Drone” now developed is expected to be an effective laser surveying system that can be installed onto conventional aircraft, obtain three-dimensional data, and help in promoting successful river management. Furthermore, since we can fly the laser from a low altitude, we are confident that we can demonstrate the constructiveness of this method in understanding topographies and variations beneath vegetation canopies or underwater bathymetry.

We will apply the results of this project to sites of river management to realize a highly efficient, highly productive river project. In addition to utilizing it at disaster sites, we will expand the range of applications to “i-Construction (productivity improvement of the construction site)” which has a high demand for knowledge of the three-dimensional topography of the above and below ground, or underwater, component.

PASCO Corporation

Representative Director and President

Hideki SHIMAMURA

MESSAGE

Prospects for innovative river management have been developed by using drone equipped green laser technology

Japan has a temperate, humid climate with four distinct seasons including heavy rains during the monsoon period. Approximately 60% of the country has an altitude of 300m or more and is classified as mountainous. These steep topographic conditions create rapid-flowing rivers. For example, the Tone River can increase its water flow by 100 times. The water flow is increased up to 60 times on the Kiso River and 30 times along the Yodo River. This water increase has contributed to repeated flooding. According to historical records, people undertook numerous river-improvement like “Namba no Horie” in the Heian Era and “Shingen Zutsumi” and “Taiko Zutsumi” in the Warring period. Currently, 50% of the population of Japan live in flood zones. This comprises about 10% of the national land area. Also, approximately 75% of the national assets are in the area.

River floods help create topography. Many people have lived along rivers since ancient times because water is necessary for rice production, and they have built levees to prevent flooding. As a result, the riverbeds have been raised leading to an increased risk of flooding. The basis of river management must be an understanding of the processes involved with rivers. For that purpose, the surveying of rivers is fundamental.

The drone-mounted green laser technology we have developed enables simultaneous survey on both land and underwater. Consequently, it is now possible to acquire the complete land-surface topography - once considered impossible by conventional river longitudinal cross-sectional survey - in a planned and detailed manner. Moreover, it can be viewed on-site in almost real time. Now, river engineers can easily understand the characteristics of the river from the 3D river topography models displayed on the screen. It is “farewell” to the limited longitudinal cross-sectional surveying method. Repeated periodic measurements will make it possible to easily grasp the river dynamics characteristic in each location. A drone-mounted green laser is a breakthrough in river surveying, an innovative technology. If transparency is still high, it will be possible to visualize the river channel situation during a flood. We hope that it will become a technology to further visualize the river bottom in muddy flow conditions.

Osaka City University

Dr. Tsuyoshi HARAGUCHI

It’s not equipment, but data

Until recently, point cloud data was valuable information obtained by laser measurements from aircraft and ground equipment. Because it uses efficient and highly spaced information, point cloud data can also be obtained by MMS. Now, with the rapid development of UAV technology, we can use photogrammetry.

The SfM method has become widely used, and UAV laser measuring instruments are generally deployed. The term point cloud is used here and there but the position of this point cloud varies widely depending on the measurement method used. I feel that it is often misunderstood for the same thing. The point group from laser measurement and the point group from photogrammetry are similar in the sense that you can express the image in three dimensions, but the scene you want to use it in is very different. In other words, it is necessary to understand how to process the information (data) obtained by measurement, how to express it, and then consider which method is best to measure.

Well, the laser instruments that can measure through water and were waited by the technicians who knew how to use them, have gradually begun to be used and are now a size that can be mounted onto any UAV. Once conditions are met you can grasp the topography under the waters surface. I think that it is better to organize information by “what kind of information is requested” and “what can be done with that data” before measurement and utilization of the information. With the introduction of new tools, the range of thought is greatly expanded. I’m thrilled to step into this unknown world. I am looking forward to it.

Gifu University

Kazuhide SAWADA

MESSAGE

Generate a new value and lay the foundation of society

For 60 years since our establishment in 1959, we have strived to contribute to the development of society by offering our customers a complete range of products with higher quality and services with specific expertise in surveying, civil engineering and construction industries.

In these industries, we are facing a shortage of workforce caused by aging population in Japan and coping with demands of rapid development by emerging countries.
To solve these problems, we certainly know that increasing productivity is the key; thus we put emphasis on the customer's perspective, and provide innovative solutions to meet the requirements of our customers. Furthermore, we deal with the customers needs quickly and ethically by holding various sales/purchase channels and production system in and out of Japan.

Surveying instrument and technologies are rapidly developed by 60 years from our establishment. Currently land surveying is done by drone. It is much faster and easier than conventional work flow for large field. Drone integrated laser scanner TDOT is very effective for shortage of workforce and increasing productivity. Everyone can easily understand operation and do surveying job by easy tutorial. Green laser scanning will inspire innovation for conventional water depth surveying work flow which is dangerous and time consuming.

As a company responsible for world social infrastructure, we will strive as one to provide valuable products and services chronically, to be the best manufacturer & supplier in surveying, civil engineering and construction industries in the future.
In conclusion, we would like to take this opportunity to ask all of our customers and partners for continued support and encouragement.

Myzox Co,. Ltd.

President

Hiroki MIZOGUCHI

DEVELOPMENT HISTORY

Development history

2000
- Development TLS (Terrestrial Laser Scanner) system

2004
- Development & sales of LiDAR by any moving vehicle from land / sea / air

2013
World first
- Drone mounted LiDAR development & sales

40,000 pulse/sec. single-echo

The best accuracy in the class

2015
- Development & sales TDOT LiDAR (current model)

2016
- Cloudization of optimal baseline analysis
- Mount TDOT LiDAR to DJI Matrice600Pro

POST-PROCESSING CLOUD

2017
The longest flight in the class

- TDOT PLUS Development & sales

60,000 pulse/sec. multi-echo

2018
- Green LiDAR Demonstration experiment

2019
World first
- Drone mounted green LiDAR go on sale