Introducing a New Class of Survey-Grade Laser Scanning by use of Unmanned Aerial Systems (UAS)

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Paper (7074)
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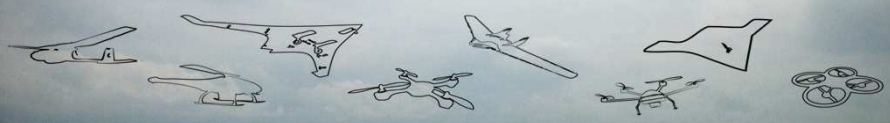
FIG XXV FIG Congress
KUALA LUMPUR 2014
"Engaging the Challenges, Enhancing the Relevance"
16 - 21 JUNE 2014, MALAYSIA

NEW
RIEGL VUX-1

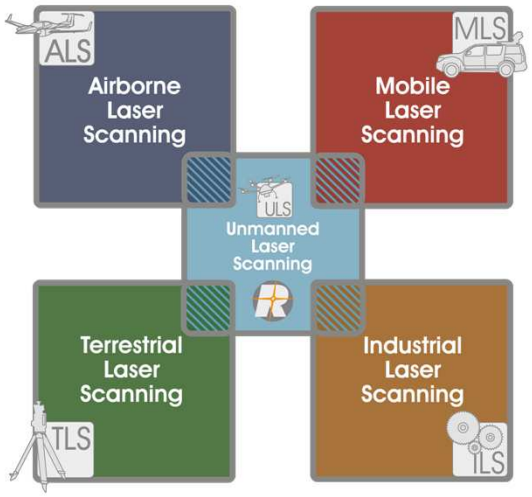
The Challenge

- New generation of aircraft opening a variety of new, complex surveying situations.
- While various types of unmanned aircraft (UAS / RPAS) are ready and about to enter civil airspace, it is time for a survey-grade LiDAR solution.



A new class in Laser Scanning

RIEGL



RIEGL

***RIEGL* VUX-1**

- measurement rate 500,000 (@550kHz PRR & 330° FOV)
- Operating Altitude >1,000 ft

***RIEGL* VQ-480-U**

- Op. altitude up to 2,450 ft AGL
- Laser PRR up to 550 kHz
- Eye safe Laser Class 1
- Lightweight: approx. 7.5 kg

***RIEGL* VQ-820-GU**

- Compact Hydro/Topo scanner
- Measurement rate 520kHz
- Fast 200 lines/sec scan rate
- Littoral zone design
- ull-waveform output

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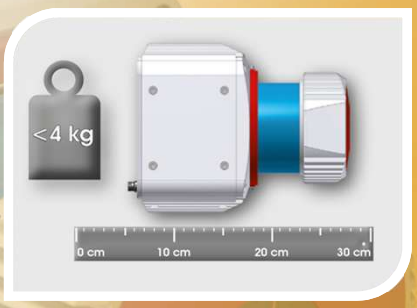
NEW RIEGL VUX®-1

RIEGL®

- **Very compact (225 x 180 x 125 mm)**
- **Very lightweight (approx. 3.6 kg)**
- High-accuracy ranging based on echo digitization and online waveform processing
- High laser pulse repetition rate up to **550 kHz** for fast data acquisition
- Fast scan speed up to **200 scans / sec.**
- Survey-grade measurement, accuracy / precision **10 / 5 mm**
- Operating flight altitude up to **more than 1,000 ft**
- Field of view up to **330°** enabling data acquisition in narrow, complex environments
- **Easily mountable to professional UAS/RPAS**
- **Internal data storage** capability (**240 GB SSD**) for several hours of data acquisition
- **Low Power consumption**, 60W (while scanning)



Ranging performance

RIEGL®

Range Measurement Performance

Measuring Principle	time of flight measurement, echo signal digitization, online waveform processing, multiple-time-around-processing

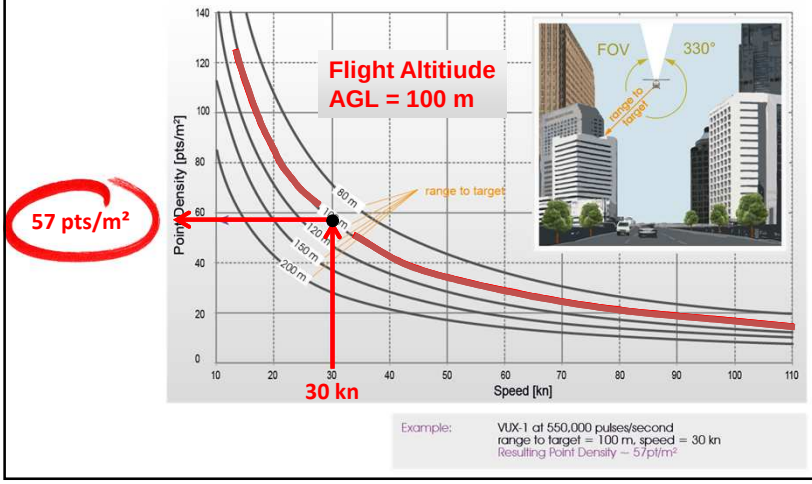
Laser Pulse Repetition Rate PRR [1]	*50 kHz*	*100 kHz*	*200 kHz*	*300 kHz*	*380 kHz*	*550 kHz*
Max. Measuring Range [2] [3]						
natural targets ρ ≥ 20 %	550 m	400 m	280 m	230 m	200 m	170 m
natural targets ρ ≥ 60 %	920 m	660 m	480 m	400 m	350 m	300 m
Max. Operating Flight Altitude AGL [1] [4]	350 m	250 m (820 ft)	180 m (590 ft)	150 m (490 ft)	130 m (430 ft)	110 m (360 ft)
Max. Number of Targets per Pulse	practically unlimited (details on request)					

1) Rounded values.
2) Typical values for average conditions. Maximum range is specified for flat targets with size in excess of the laser beam diameter, perpendicular angle of incidence, and for atmospheric visibility of 23 km. In bright sunlight, the max. range is shorter than under overcast sky.
3) Ambiguity to be resolved by post-processing with RIMTA software.
4) Reflectivity ρ ≥ 20%, flat terrain assumed, scan angle ±45° FOV, additional roll angle ±5°.

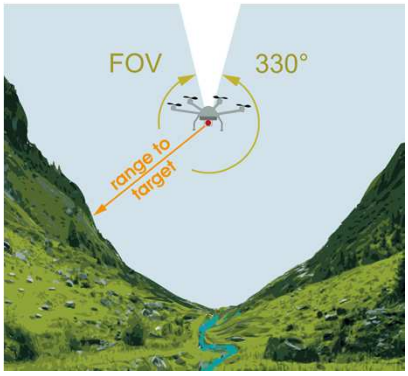
Minimum Range	
Accuracy [5] [7]	10 mm
Precision [6] [7]	5 mm
Laser Pulse Repetition Rate [1] [8]	up to 550 kHz
Max. Effective Measurement Rate [1]	up to 500 000 meas./sec. (@ 550 kHz PRR & 330° FOV)
Echo Signal Intensity	for each echo signal, high-resolution 16 bit intensity information is provided
Laser Wavelength	near infrared
Laser Beam Divergence	0.5 mrad [9]
Laser Beam Footprint (Gaussian Beam Definition)	50 mm @ 100 m, 250 mm @ 500 m, 500 mm @ 1000 m

Range Measurement Performance

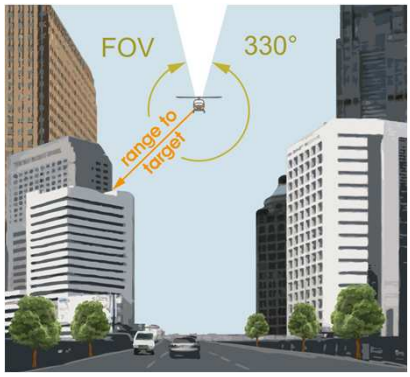
PRR = 550kHz



Field of View

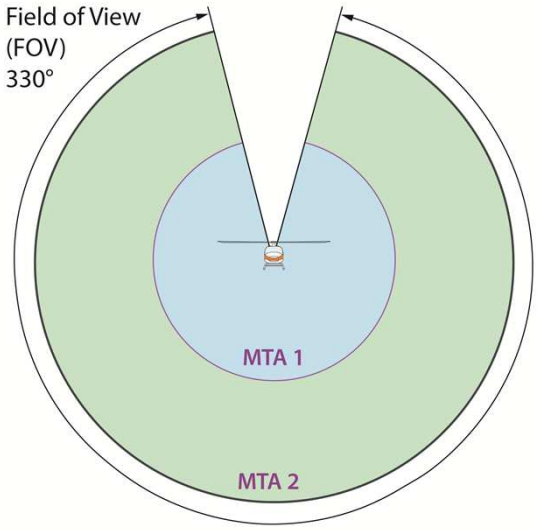


FoV, valleys



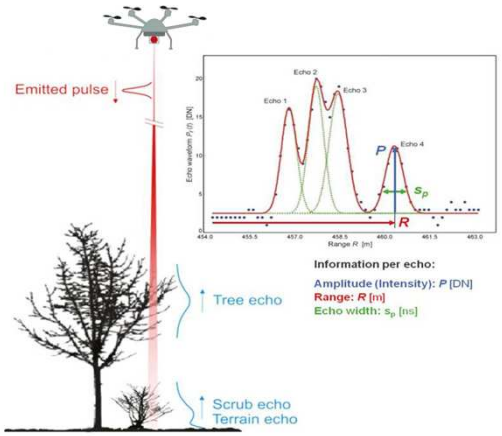
FoV, urban canyons

Multiple Time Around



Multiple Target Capability

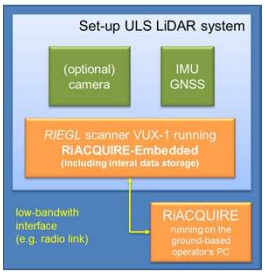
Interaction of Laser Pulse with Target



Advantages

- High multi-target resolution
- High accuracy of multi-target echoes
- Pulse width estimation
- Enables radiometric calibration
- Excellent penetration of vegetation
- Accurate digital elevation map
- Improves classification process
- Remote control and autonomous operation capability

Set-up ULS LiDAR system



- Easily mountable to professional UAS
- Remote control and autonomous operation using *RIEGL's* RiACQUIRE-Embedded

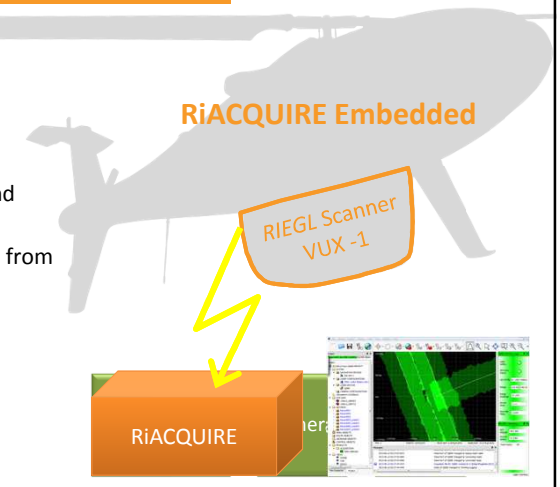
RiACQUIRE-Embedded

RiACQUIRE-Embedded

- running on *RIEGL* VUX-1
- stores all raw data on lean DR
- controls image acquisition
- prepares monitoring trajectory and scanner data for data transfer
- listens to and executes commands from ground-based RiACQUIRE

RiACQUIRE

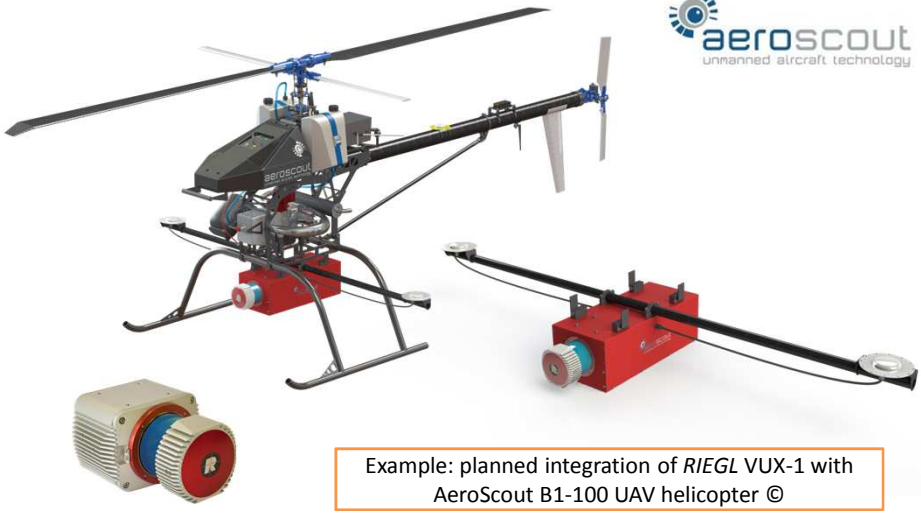
- acts as master
- transfers data via radio-link
- **usual interfaces and feedback to operator on the ground**



System Set-Up (1)
Flying-Cam, Belgium

Example: planned integration of *RIEGL* VUX-1 with Flying-Cam SARAH 3.0 ©

System Set-Up (2)
Aeroscout, Swiss



Example: planned integration of *RIEGL* VUX-1 with AeroScout B1-100 UAV helicopter ©

System Set-Up (3)
Bygg Control AS, Norway

Example: planned integration of *RIEGL* VUX-1 with Camflight X8 ©

System Set-Up (4)
Near Earth Autonomy, USA

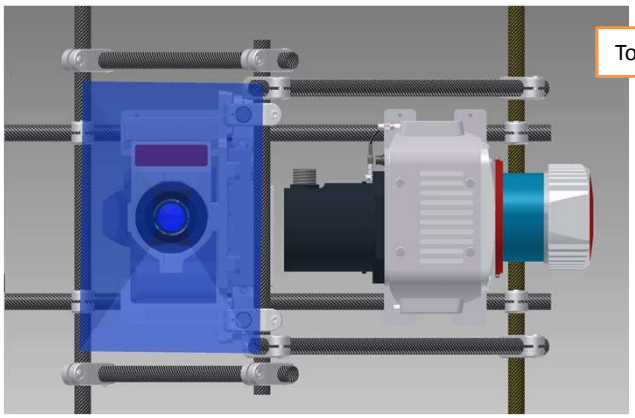
Example: planned integration of *RIEGL* VUX-1 with NEA helicopter

System Set-Up (5)
Geo-Info & RedChina, China

1st test flight LAST WEEK

1st INTEGRATED *RIEGL* VUX-1 in UAV-System © Geo-Info, GL70

System Set-Up (5)
(Preliminary)



Top 3D view

Example: preliminary system set-up together with the *RIEGL* VUX-1

Environmental Monitoring

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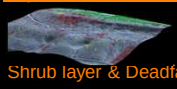
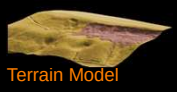
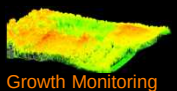
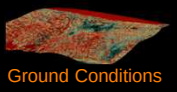
Layers of Information

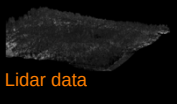

Shrub layer & Deadfall

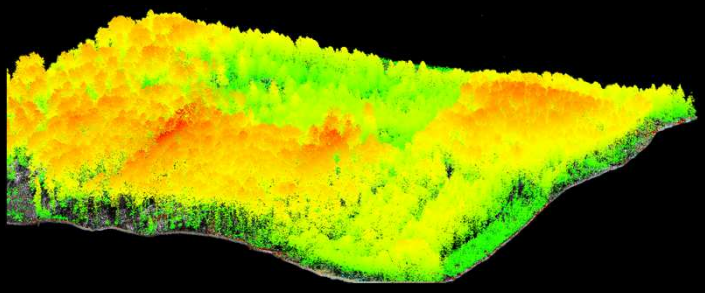

Terrain Model


Growth Monitoring


Vegetation


Ground Conditions


Lidar data



Tree Height Model

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Example Applications

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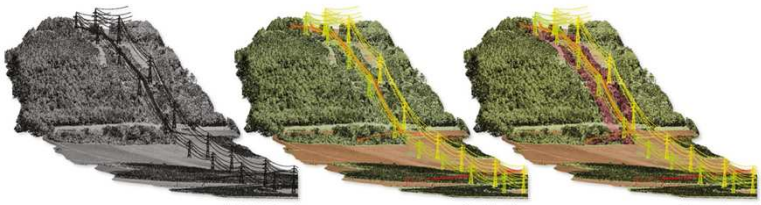
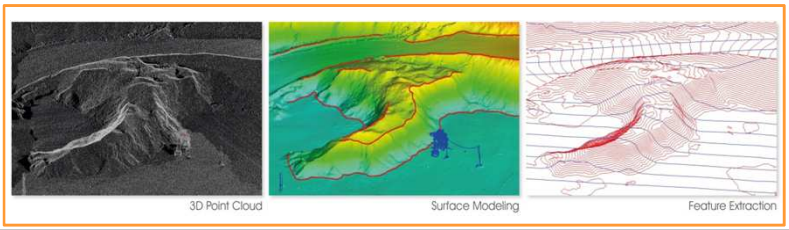
Application: Power Line Inspection & Infrastructure Monitoring

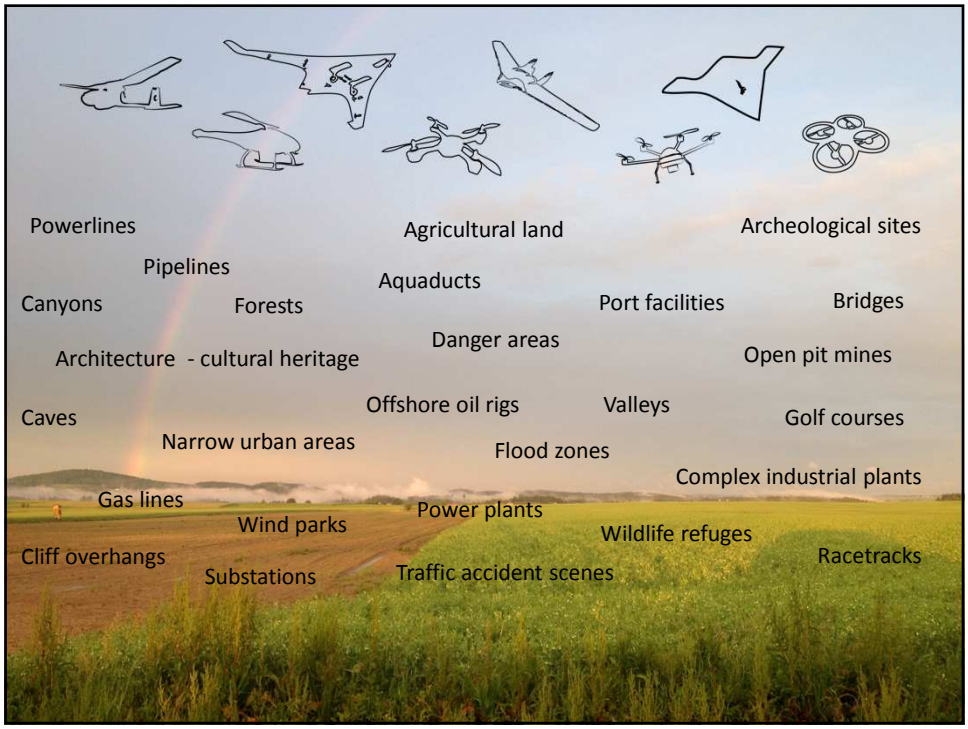


Application: Topography in Open-Pit Mining Areas



Live Data Demo (Video)

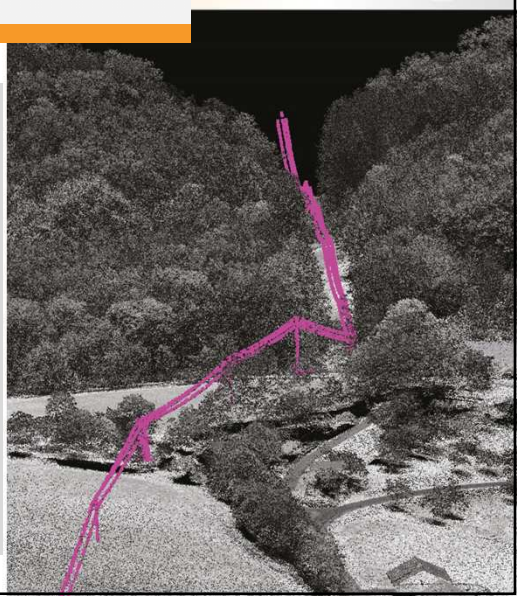
First recently acquired VUX-1 scan data



Recap

***VUX-1*:** The world's first UAS based LiDAR sensor enabling laser scanning in professional surveying quality for an emerging market

ULS : the innovative link between airborne, mobile and terrestrial laser scanning



RIEGL

Thank you
for your kind attention!

Visit us @ booth 32 (*RIEGL* / GPS Lands)

FIG KUALA LUMPUR 2014

Innovation in 3D