The State of Commercial Aerial Sensors Technologies and the Geospatial Industry

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About Woolpert

• Established in 1911
• Over 850 Professionals
• 25 Offices
  • Dayton - Headquarters
With the ability to explore above, on and below Earth's surface, we excel in providing cutting-edge geospatial services to lead and support complex, multidisciplinary projects.
Geospatial Services

- Aerial Mapping
- Mobile Lidar
- Terrestrial Lidar
- Surveying
- GIS
- Bathymetry
Today’s business is all about layered sensing
What The Industry Expect from Aerial Sensors?

1. Multi-spectral georeferenced Imagery (RGB and CIR)
2. Points Cloud
3. Video for inspection
Point Clouds

What is it?
It is 3D points with known X, Y, Z used to represent the terrain or in space.
Sources of Point Cloud

1. Imagery
2. Lidar
3. Microwave Sensors
Points Cloud from Lidar
The State of Lidar Technologies

• Since early 90’s, lidar served the geospatial, engineering and construction communities relentlessly and successfully

• Lidar became an integral part of the sensors group for collecting 3D geospatial data

• Lidar technologies is ever evolving and manufacturers surprises us every year with new innovations
Whether it is...

Mobile Lidar
Mobile Mapping System Technology (MMS)

1,000,000 points per second (2,000 pts/m² to 6,000 pts/m²) Accuracy≤1.8 cm
or...

Static Lidar
or...

Aerial Lidar
Helicopter-based Lidar

**Points Density:**
few pts/m² to >100pts/m²

**Accuracy:** 2 cm to 15 cm

**Altitude:** 200 to 300’ AMT
Fixed Wing-based Lidar

Points Density:

0.25 pts/m² to <10 pts/m²

Accuracy: 5 cm to 15 cm

Altitude: 2,000 to 8,000’ AMT
or...

Bathy Lidar

Courtesy: Geomatics Data Solutions
And now...

**UAS-based Lidar**

700,000 points per second with accuracy of +/- 2cm.
Lidar Gave Us Everything We Needed
Lidar Gave Us Everything We Needed
Lidar Gave Us Everything We Needed
Creative Static or Mobile Lidar Systems

Image courtesy: Teledyne Optech
Great Mobile Mapping Systems (MMS) in the Market

- Optech Lynx_SG
- Leica Pegasus_Two
**PulseTRAK**
- Truly continuous operating envelope for maximum efficiency
- No data gaps or density loss across PIA/MTA zones

**SwathTRAK**
- Dynamic FOV: fewer flight lines and constant point distribution
- Increased range of motion: survey the steepest mountains

**More Range, More Density**
- 30% increase in range performance and/or increased point density
- “Night mode” increases range performance further still
Latest RIEGL Waveform-LiDAR Technology

- **RIEGL VQ-780i**
  - atmospheric clutter suppression
  - acquisition of up to 300 km²/h at 8 pts/m²

- **RIEGL miniVUX-1DL**
  - field of view optimized for corridor mapping
  - 100 pts/m² for typical multi-rotor copters

- **RIEGL VMX-2HA**
  - 2 million measurements/sec
  - flexible camera system with up to 9 cameras

- **RIEGL VZ-2000i**
  - up 60 scan positions/hour
  - up to 2,500 m range

www.riegl.com
Linear mode: TerrainMapper
- 2.0 MHz pulse rate
- Advanced scanning optics for 5500 m AGL
- Gateless MPIA (to 35 zones)

Single-photon mode: SPL100
- Automatic range gate
- Direct intensity measurement
- Hi-res scan angle encoding

Processing: RealTerrain
- Auto calibration
- Registration
- Line-line, intra-line QC
- Distributed processing
What is Next for lidar?

Increased Efficiency and Productivity
The birth of:
Flash, Geiger Mode, and Single Photon Lidar
Linear mode Lidar, Geiger-Mode Lidar (GML), Single-Photon Lidar (SPL):

It is all about harvesting the laser energy...

In Linear mode Lidar, a laser pulse received by single pixel receiver...
The difference between current Lidar and Single Photon/Geiger Mode Lidar

Diffractive Optical Element

Target

Input laser beam

Diffractive Optical Element

Source laser pulse

Spot image received at the single anode

Source laser pulse

Array of split back scatter received by the receiver

Linear Lidar
One-to-one

Single Photon Lidar
One-to-many
Single Photon Lidar Samples
25 points/sq m
Woolpert Role in Developing the New Lidar Technology

South Dakota Project

- Woolpert was recently tasked by the USGS to use the Single Photon Lidar to collect QL1 data for 5 counties in South Dakota
- Data was acquired and delivered successfully
This task includes 3,726 square miles of high density USGSv1.2 specification, QL1 or better Single Photon Lidar acquisition and processing. The AOI is located in southeast South Dakota and consists of Aurora, Buffalo, Brule, Jerauld, and Charles Mix Counties.
The latest in
Digital Aerial Cameras

For manned aircraft
Multiple Configurations, Multiple Options

- Courtesy Microsoft - Vexcel
- Courtesy Vision Map
- Courtesy Intergraph
- Courtesy Leica Geosystems

DMC II2 250
DMC II2 230
DMC II2 140

PHASEONE
INDUSTRIAL
Hexagon DMC III
25,728 pixels across swath
The Largest Camera in the Market: VEXCEL UltraCam CONDOR 37,800 pixel swath width
Hexagon ADS100
CCD linear array size*: 20,000 pixels
190MP Aerial System
FLIR SC8300 Thermal Camera
Resolution $1,344 \times 784$ pixel
The latest in
Cameras For
unmanned aircraft
Camera on board small Unmanned Aerial System (UAS)

- Mostly consumer grade cameras:
  - Sony
  - Panasonic
  - Canon
  - Nikon
  - GoPRO
Imagery-based Points Cloud Sample

3D Point Clouds & Textured Meshes from Imagery
Imagery-based Points Cloud Sample

Passive point clouds

3D Point Clouds & Textured Meshes from Imagery

Source: acute3D
RGB 2-cm Mosaic - UAS
Points cloud from imagery

210 points/m²
Points cloud from imagery

210 points/m²
Points cloud from imagery
210 points/m²
Low Altitude Aerial Imaging: RENAISSANCE™

- Driven by Affordability
  - Consumer Grade Camera
  - Single-Engine Aircraft
  - Pilot-Only Operation
  - Fly places where UAS can’t
  - Computer-Vision Processing
Typical products from Renaissance:

• 2-cm Orthos
• 40 to 100s pts/m² point clouds
Bypass Construction project
2-cm Orthos Details
Imagery-based Points Cloud Sample
Bypass Construction project
2-cm Renaissance System
Imagery-based Points Cloud Sample Bypass Construction project
Imagery-based Points Cloud Sample Bypass Construction project
Final Remarks on aerial imagery and Lidar market

• Aerial imaging technology in general is keeping up with users needs and demands
• Unmanned aerial system is providing opportunities that otherwise would not be affordable when using large metric cameras
• License-base aerial imagery is getting traction within civilian users
• High resolution space imagery is not attracting civilian users
• The new lidar technologies, GML & SPL are in productive mode but are slow in penetrating the market
• Linear mode lidar technology is witnessing great advancements and it is not going away any time soon
• GML & SPL will phase out many of the linear mode lidar units in the coming decade
Thank you!

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