LiDAR and Digital Imagery for High Precision Projects

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Presentation

- Quality Assurance Process
  - System Calibration
  - Planning
  - Aerial Survey
  - Primary Processing
  - Secondary Processing
  - Delivery

- Case Study : A14, Cambridgeshire, England

Quality Assurence

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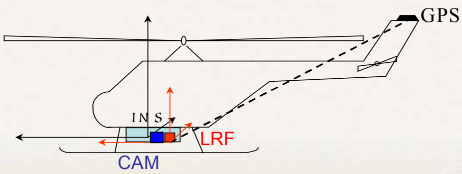
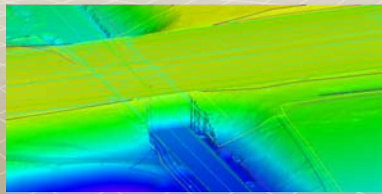
- System calibration
  - Camera calibration
  - Laser Range Finder (LRF)
  - Scanner
  - GPS Lever Arm
  - Time syncronization
  - LRF/Camera offset
  - LRF/Camera rotation - Boresight calibration



- Project realization
  - Planning
  - Data capture
  - Data processing
  - Delivery



Quality Assurence

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From planning to delivery

- Planning
  - Accuracy demands
  - Flight plan: Altitude, speed, overlap, etc..
  - GPS reference stations
  - Ground control for QC/QA
- Aerial survey
  - Secure good GPS constellation
  - INS initialisation and drift control
  - Supporting flight lines for QC/QA
- Primary processing
  - GPS/INS processing
  - Point cloud calculation
  - Strip adjustment, TerraMatch
  - TASQ – quality statistics of strip overlap
- Secondary processing
  - Filtering – ground classification, manual editing
  - Classification of buildings, trees, etc..
  - Modelling, e.g. DEM
- Delivery

LiDAR versus Photogrammetry

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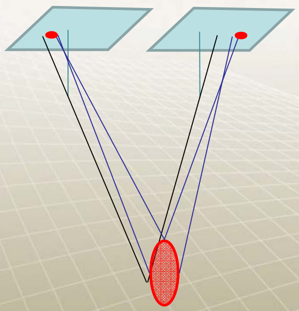
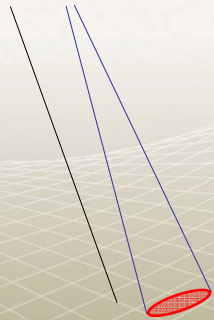
Photogrammetry



$2\ \sigma_{XY} > \sigma_Z > 5\ \sigma_{XY}$

LiDAR



$2\ \sigma_Z > \sigma_{XY} > 5\ \sigma_Z$

LiDAR versus Photogrammetry

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Photogrammetry

High planimetric resolution - 5 cm

RGB

LiDAR

Low planimetric resolution - 25 cm

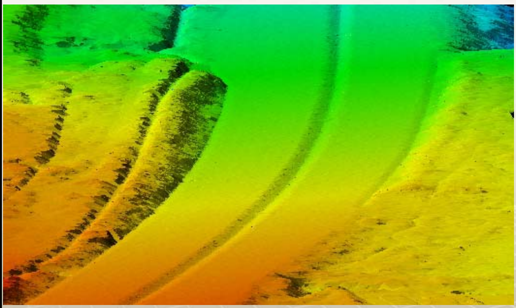
15 points / m^2

nIR

LiDAR and Photogrammetry

High elevation accuracy

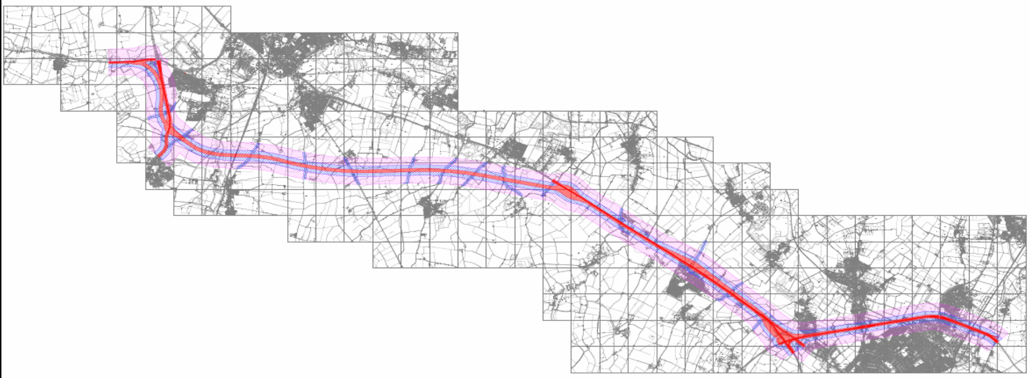
High planimetric accuracy and resolution
Good conditions for image interpretation



The combination gives best result

Case study – A14, Cambridgeshire

- 100 m (330 feet) AAG (Altitude Above Ground)
- > 30 points / m^2 LiDAR point cloud
- 2 cm digital image resolution, Rollei AIC P20 (4000x4000 pixels)
- < 5 km to GPS reference stations, logging 1 Hz dual frequency phase data
- 140 flightlines
- 34 survey stations established along A14 – 1190 control



A14 – Primary Processing

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- LiDAR point cloud calculated with Topeye TEPP SW
- Topeye elliptic scan pattern – Forward and Backward scan – adjustment of Heading and Pitch errors using TerraMatch
- Strip adjustment correcting Easting, Northing, Z and Roll errors per flightline
- Adjustment towards ground control
- Statistical analysis of deviations between flightlines using Blom SW TASQ
- Digital Images developed in Capture One SW

TASQ – Report

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TASQ (TopEye Area Statistics and Quality) output report

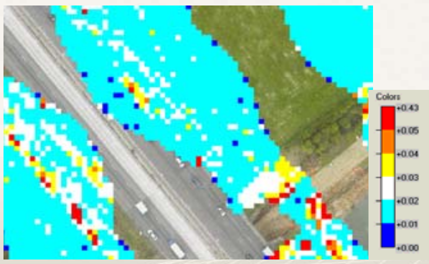
Statistics for elevation differences between flightlines

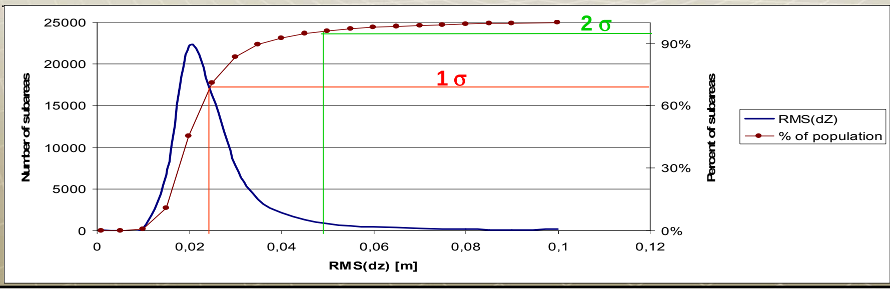
Global statistics

Total RMS(dZ) : 0.024 m
Number of observations: 891501
Maximum deviation : 0.430 m

Flightline statistics

Flightline number 329
RMS(dZ) : 0.023 m
Number of observations: 192813
Mean deviation : -0.008 m
Maximum deviation : 0.240 m



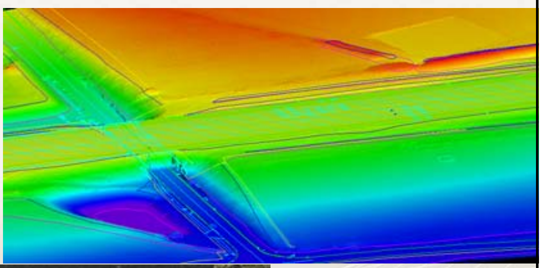


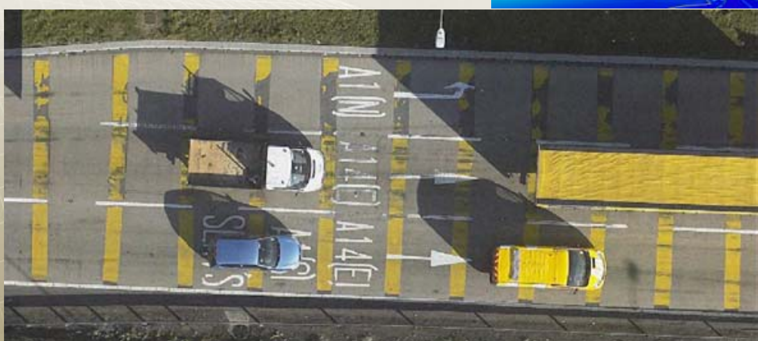
A14 – Secondary Processing

- Isolate data representing A14 asphalt area. Resulting in only hits on the asphalt road.
- Smooth the data on asphalt. This reduces the noise in the data and gives a smoother dataset.
- Compare point cloud to survey detail (20 – 40 points / km) and shift accordingly. The corrections varied within +/– 4cm.
- GPS/INS orientation of Digital Images refined by tie point measurements and triangulation. Adjustment to ground control.

A14 – Final Result

- 25 check points
- RMSE Z – 0.013 m
- RMSE Easting – 0.020 m
- RMSE Northing – 0.017 m





Summary and conclusions

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- High precision reachable only with careful planning and processing in all stages: calibration, planning, data collection, processing and delivery
- LiDAR length precision dependent on high S/N ration – don't fly too high
- High precision reachable only with data enhancement procedures, such as strip adjustment and smoothing
- Smoothing only applicable on surfaces with lower noise level than LiDAR point cloud, such as asphalt
- Combine LiDAR and photogrammetry for best result