Drones for Gravity Terrain Corrections

An aerial solution to digital elevation models and gravity terrain corrections
Introduction:

- Contract Gravity and Magnetic Surveys since 1980
- Surveys in more than 40 countries
- Drone operations since 2014
- Fixed wing drones for DEM / Orthophoto mapping
- Hexacopter for Drone Magnetic Surveys
- More than 1000 flights completed
Gravity Survey Equipment:

Electronic gravity meters: <15 micro-gal accuracy
GNSS Positioning: mm accuracy
Gravity Survey Equipment

Gravity Surveys require high precision in all three phases of data collection:

• Gravity Measurement
• Positioning
• Terrain Mapping & Corrections

• Electronic gravity meters can collect data accurate to 0.015 mgals
• GNSS positioning can measure positions to 5mm
• Existing public sourced digital elevation models can be course, potentially inaccurate and out of date.
• Site specific high resolution elevation models can be acquired economically by Mapping Drones.
Terrain Correction Evolution:

1970:
- Inclinometers & range estimates or topographic maps and templates.
  - Poor accuracy and highly variable.

2005:
- Reflector-less hand held lasers and/or GNSS survey
  - Good results in limited areas
  - Laborious
  - Prone to errors

2015:
- DEM
  - Good quality in some areas of the world
  - Limited availability
- LIDAR and remote sensing surveys:
  - Accurate
  - Vegetation not a hindrance to elevation model
  - Relatively expensive, Complex logistics
- Drone based Mapping
Mapping Drone
Case Study Results:

- 2398 photos
- 6.5 square kms
- 3 days, 11 flights
- Export 1m Digital Surface Model
- 10800 gravity stations
- Average vertical offset surveyed sites to DEM: 0.10m
SRTM 1second elevation model

Approximately 850 data points within a 6.5 km² survey area. This model would be unable to produce the high accuracy terrain corrections required for a micro-gravity survey and results in poorly corrected gravity data and unreliable results.
Using the Drone based mapping system, over 2000 photos were acquired over the 6.5 km² survey area and processed to produce a high accuracy 1m elevation model. The resultant DEM has 6.5 million data points. This terrain model allows very high accuracy terrain corrections and facilitates a reliable micro-gravity survey.
3D Orthophoto of Survey Site

3D render of 1m drone acquired terrain model.
Orthophoto of Mine pit

9/25/2017
Topographic Profile

Line 43 Terrain Correction Comparison

North -- Horizontal Distance (m) -- South
Bouguer Gravity no Terrain Correction
Bouguer Gravity with SRTM Terrain Correction
Bouguer Gravity with Drone Terrain Corrections

Line 43 Terrain Correction Comparison

North — Horizontal Distance (m) — South
Residual Gravity No Terrain Corrections
Terrain Corrected by Drone DEM
Drone Mapping Experience (600 flights):

Advantages:

- Cost effective method of creating elevation models.
- Highly accurate
- Allows us to create larger scale elevation models than could never be created with land based survey solutions.

Limitations:

- Reliability and maintenance
- Suitable for areas of 200 square kms or less
- Tree & Vegetation cover impacts elevation model
- Processing time & computing resources
- Requires precise ground control
Summary:

- Drone derived Digital Elevation Models are a viable option for terrain correcting gravity surveys
- Tremendous accuracy; typically better than 25cms
- Resultant DEM yields extremely accurate terrain corrections to match modern gravity survey equipment resolutions
- Cost effective
- Simple logistics