Unmanned aerial vehicles in municipality level 3D topographic data production in urban areas

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Motivation for the project

• Topographic data from municipalities will have a significant role in the forthcoming National Topographic Database

• Potential of new mobile mapping methods, such as UAVs, for updating 3D topographic data in urban areas needs to be investigated

• Usage of UAVs have increased rapidly:
  – UAV regulations are not clear to all and they have significant impact on the usability
  – More knowledge of the UAV-photogrammetry is needed in order to understand the benefits and limitations of UAV-photogrammetry
  – Guidelines and general knowledge of UAV-based methods is needed!
Project questions:

• Can UAV-photogrammetry:
  – produce accurate- and reliable-enough data for municipality level 3D topographic data?
  – reduce manual labor in the field and provide cost-efficient map updating in urban areas?

Project goals:

• Evaluation of usability of UAV-based mapping in urban areas
• Produce preliminary guidelines for UAV-based 3D topographic data production
Overview of UAV-based 3D topographic data production

1. Planning phase
2. Measurement phase
3. Data processing phase
1 Planning phase

- General planning and measurement method decision
  - Geographical area, required accuracy, accessibility ...

- Legislation and risk management
  - Local UAV-regulations
  - Population density

- Flight planning
  - Safety
  - Accuracy requirements, ground control points (GCPs)
  - UAV and sensor
2 Measurement phase

- Final decision of flight and its parameters
- Ground Control Generation
- Aerial imaging
3 Data processing phase

- Photogrammetric processing
- Accuracy Evaluation
- Vectorization of data to a topographic data format
Test-case: Vihti, Finland (October 2016)

- Nummela center, 49 hectares
  - Densely populated area
  - Small airfield
  - Various building types
Planning I

- Finnish regulation by the Finnish Transport Safety Agency (Trafi)
- Risk assessment report & UAV manual
- Informing the airfield and creation of aviation warning (NOTAM)
- Notification / bulletin to residents
- Flight planning
  - Flight trajectories, Visual-line-of-sight (VLOS)
  - Lift-off / Landing site
Planning II

- Flight plans: Three nadir imaging flights
Measurements

• The UAV-system:
  – Tarot 960 foldable frame
  – 3DR Pixhawk with Arducopter
  – Approx. 6 kg
• Samsung NX500 RGB camera
• GCPs measured with Trimble R10 VRS-RTK- GNSS system
• Fully sunny day
Data processing

• Processing using Pix4D
• Ground Sampling Distance (GSD): 2.93 cm
• Number of images: 1334
• Ground control Points (GCP) 10 kpl
  – RMSE: X 0.0021 m, Y 0.0014 m, Z 0.0015 m
• Image overlaps:
  – Forward overlap 90%
  – Sidelap 70%
• > 800 points / m²
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Transition to augmented reality
Vectorization

- Work has been concentrated on buildings and automatic methods
  - Automatic building vectorization using TerraScan software (Terrasolid Ltd., Helsinki)

- There’s a lack of automatic methods for other targets than buildings
  - Manual labor is still required a lot in the data vectorization
RPAS-aineiston automaattinen luokittelu

- buildings
- ground

Kuvat: Tomi Rosnell
Conclusions

- UAV-photogrammetry provides low cost tool for producing 3D topographic data in urban areas, especially when small areas are of concern.

- Automated methods for point cloud vectorization needed.

- The use of UAVs in topographic data production will increase.

- UAV-based laser scanning will also increase as the sensors are getting smaller and prices are going down.
Kiitos!
Questions?

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