Applied surveying education: documenting cultural heritage in 3D in the city of Ghent (Belgium) using laser scanning and photo modelling

Annelies VANDENBULCKE, Marijke DE RYCK, Cornelis STAL, Rudi GOOSSENS, Alain DE WULF, Belgium

7th century hospital, 14th century abbey, 17th century monastery, nowadays: extended and restored as Ghent City Museum called "STAM"
City of Ghent (Belgium) and the Ghent University, Department of Geography work together to document and measure important cultural heritage sites in 3D.

This partnership enables Master students in Geomatics and Surveying at the Ghent University to take part in a project driven measuring campaign: the Data acquisition of the Ghent City Museum (Stadsmuseum or STAM).

After successful completion of the course, students have gained a significant expertise concerning the processing of topographic data, 3D point clouds and imagery in an integrated way.
Data acquisition using
1. Engineering surveying with total station and GNSS
2. Photo modelling
3. Terrestrial laser scanning

Expected results:
1. extensive quality control by comparison of the techniques
2. high-level 3D model
3. orthophoto maps useable for documentation/restoration

1. Engineering surveying using GNSS and total station
   • Determination of a first set of ca. 10 Ground Control Points (GCP) with Trimble R8 (FLEPOS) RTK-GNSS receivers (1-2 cm), to georeference all measurements in the Belgian Lambert72 conic coordinate system (EPSG 31370)

   • Second set of GCPs consists of highly distinguishable features on the walls (min. 40/wall), measured by Trimble M3 total stations and connect to the GNSS points.

   • A third set of points are the target points used for the terrestrial laserscanning, also connected to the GNSS points.
2. Photo modelling

- Canon EOS 1Ds camera (11 Mp), full frame (24mm x 36mm), 50 mm lens, photoscale approx. 1/500 (ca. 25 m distance).

- Images are processed using a Structure from Motion and Multiview Stereo (SfM-MVS) workflow (software: Agisoft Photoscan Professional)
  - Detection of feature points
  - Feature point matching between consecutive images
  - Building of a 3D geometry using triangulation or meshing
  - Texture map is added

- Results: 3D point cloud with photorealistic colors, 3D meshed geometry with texturing, orthophoto maps,…

2. Photo modelling: resulting 3D model
3. Terrestrial laser scanning

- Leica phase-based laser scanner HDS6100 (accuracy of 1-2 mm at 25 m distance).
- Resolution level of 0.018° → a point spacing of 8 mm at a distance of 25 meter.
- Processed using target-to-target registration in Autodesk Recap Pro
- Point cloud with artificial colors (reflection strength)
Analysis: Comparing results of photomodelling and laserscanning with "total station / GNSS truth" using statistical analysis (using GCP as ground truth)

**RMSE of the control points (m) comparison between photomodelling and laser scanning**

- **X**
- **Y**
- **Z**
- **3D**

**Systematic error of control points (m) comparing photo modelling and laser scanning vs. total station measurements**

- **X**
- **Y**
- **Z**
- **3D**
Conclusion

- Students
  - Use and compare several 3D data acquisition methods
  - Implement their theoretical knowledge in the field
  - Are stimulated by the fact that the work they are doing is really useful for historical heritage conservation
  - Experience the challenges of working together on a real-world project
  - Are encouraged to think outside-the-box
Thank you for your attention

Contact & Information:
Annelies.Vandenbulcke@UGent.be
Marijke.DeRyck@UGent.be
Cornelis.Stal@UGent.be
Rudi.Goossens@UGent.be
Alain.DeWulf@UGent.be

Ghent University, Department of Geography, Ghent (Belgium)