USE OF AIRBORNE LASER SCANNING DATA FOR UPDATING TOPOGRAPHIC MAPS AND DATABASES

DUŠAN PETROVIČ
University of Ljubljana, Slovenia
Faculty of Civil and Geodetic Engineering
email: dusan.petrovic@fgg.uni-lj.si
CONTENT

- Motivation: problem with updating topographic data
- Airborne laser scanning (LiDAR) technology, products
- DEM updating
- Extraction of characteristic objects (water streams, ridges, roads, paths)
- Savings in particular maps production
- Conclusions
Topographic data - the basic part of spatial data infrastructure.

Regularly updated spatial data are essential for:
- administrative tasks,
- spatial management and
- environment monitoring,
- many other purposes.

Traditional methods for capturing and regular updating:
- aerial photogrammetry,
- field checking →
- too expensive and
- too time consuming for costumers and for also for national mapping agencies’ budgets.
Topographic data situation in Slovenia

- DTK 50; regularly updated
- DTK 25; precise, out of date
- DTK 5; not homogenous, not updated, does not cover the whole area of the country
<table>
<thead>
<tr>
<th>Ideas for updating of topographic data</th>
<th>+</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data from companies responsible for public infrastructure</strong></td>
<td>- Precise, complete, and updated data already exists</td>
<td>- Dependence on the policy and its realisation, unhomogenous</td>
</tr>
<tr>
<td><strong>Data fusion from different sources</strong></td>
<td>- Use of existing data sources, relatively cheap production</td>
<td>- Different, sometimes unknown quality of data</td>
</tr>
<tr>
<td><strong>By individual users (crowdsourcing)</strong></td>
<td>- Low expenses</td>
<td>- Quality of data = ?</td>
</tr>
<tr>
<td><strong>LIDAR data</strong></td>
<td>- In 2 years point clouds and DEM will be available for the whole country, - Appropriate positional precision</td>
<td>- New knowledge, procedures, and software are needed</td>
</tr>
</tbody>
</table>
Updating of official topographic data by users

User, capturing changes (GPS, personal visual interpret.)

Client / server application

Client

Server

Updated map

administrator

Client

Server

Updated map
<table>
<thead>
<tr>
<th>Ideas for updating of topographic data</th>
<th>+</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data from companies responsible for public infrastructure</strong></td>
<td>- Precise, complete, and updated data already exists</td>
<td>- Dependance on the policy and its realisation, - unhomogenous</td>
</tr>
<tr>
<td><strong>Data fusion from different sources</strong></td>
<td>- Use of existing data sources, relatively cheap production</td>
<td>- Different, sometimes unknown quality of data</td>
</tr>
<tr>
<td><strong>By individual users (crowdsourcing)</strong></td>
<td>- Low expenses</td>
<td>- Quality of data = ?</td>
</tr>
<tr>
<td><strong>LIDAR data</strong></td>
<td>- In 2 years point clouds and DEM will be available for the whole country</td>
<td>- New knowledge, procedures, and software are needed</td>
</tr>
</tbody>
</table>
The airborne laser scanning data - promising source data for deriving different topographic data.
Deriving data from ALS:
- classification
- automated (urban environment or forestry)
- manual recognition from derived presentations (e.g., hillshading)
Which objects and phenomenon can be recognised from ALS data?
small test areas on different parts of Slovenia representing different types of terrain:

area near Ljubljana: steep continental relief
area near Domžale: steep karst terrain
area near Lipica (Karst): moderate karst terrain,

first echo

- O-map
- ALS hillshading
- ALS derived contours
* 0.5 m, 5-15pt/m2
Can we use ALS data for correction of existing DTM?
area Koroška Bela (KB), 2 × 1,6 km, DMV 0,5 m
5/2009, flying height 1000 m, Flycom, purpose flood risk

area Jereka (JE), 2 × 1,2 km, classified point cloud ~ 12 pt/m²
7/2008, flying height 500 m, Flycom, purpose power lines measuring

area B21, Izola - Markovec (IZ), 2 × 2 km, DMV 1 m
5/2011, Geoin, systematic capturing for Slovenia

area A6, Letuš (LE), 1,5 × 1,5 km, DMV 1 m
5/2011, Geoin, systematic capturing for Slovenia
area Koroška Bela (KB), 2 × 1.6 km, DMV 0.5 m
5/2009, flying height 1000 m, Flycom, purpose flood risk
area Jereka (JE), 2 × 1.2 km, classified point cloud ~ 12 pt/m², 7/2008, flying height 500 m, Flycom, purpose power lines
area B21, Izola - Markovec (IZ), 2 × 2 km, DMV 1 m
5/2011, Geoin, sistematic capturing for Slovenia
area A6, Letuš (LE), 1,5 × 1,5 km, DMV 1 m
5/2011, Geoin, sistematic capturing for Slovenia
extraction of linear objects from Lidar data
Main goal: estimation of possibilities to automate the extraction of roads, paths, water streams, ridges and ditches form high resolution DEM in hilly and mountain areas
1. Approach:
Extraction of water streams, ridges and ditches

- natural objects, depend on relief characteristics

Water streams, ditches

- Hydrological tools were used:
  - Multiple Flow Detection model
  - Flow accumulation
  - Setting appropriate threshold
  - Converting to vector

Ridges

- Inverting DEM
- The same procedure as above
- Different threshold
Results: water streams, ridges, ditches

Problems
- yellow: the ridge was not detected
- green: problems with detecting ditches at the junctions with paths
kaj pomenijo oznake elips?
Verjetno gre za napake ... obrazložiti

Grafično merilo se pojavi šele na tej sličici -> na vse
- dovolj bi bilo 500 m merilo z okoli 3 št. oznak

Tomaž Podobnikar; 24.6.2011.
Comparison to existing data (DTK 25): ridges, ditches
kaj pomenijo oznake elips?
Verjetno gre za napake ... obrazložiti

Grafično merilo se pojavi šele na tej sličici -> na vse
- dovolj bi bilo 500 m merilo z okoli 3 št. oznak
Tomaž Podobnikar; 24.6.2011.
2. Approach: Extraction of roads and paths

Focus on extraction of paths in the slopes

Workflow:
- slope, aspect, curvature and derivatives in x- and y- directions from DEM
- hillshading with vertical angle 90°
- pre-processing of the image (noise reduction, more contrast)
- image processing tools:
  - edge detection with canny method
  - improving the results with Wiener filter;
  - removing of short segments
Results: roads, paths

Problems:
- other sharp relief edges were also detected: riverbeds, edges of shores...
Comparison to existing data: roads, paths
Maps made using LiDAR data
KOSEŠKI BAJER

Merilo 1 : 5000
Ekvidistanca 2,5m
Stanje: maj 2010

Izdelaš:
Gregor Anderluh
Dušan Petrovič
Lavra Babič
Brigita Mandelj
Mirjana Pešić
Nina Kerpan

Vir:
DTK 5, DOF
Reambulacija in prijetno druženje:
Gregor Anderluh
Mario Vatto

Posebni znaki:
× Tarča
- Klopca
○ Drugi objekti
= Cyprinus caprio

Karta je bila izdelana ob pomoči Fundacije za šport

Sprint map (ISSOM)
DEM 0.5 m
50% time
SKI-O map
8 sq.km
DTK5
DEM 0.5 m
DSM 5 pt/m2
orthophoto 0.5 m
GPS (ratrac, scuter)
2 hours field check
SKI-O map
8 sq.km
DTK5
DEM 0.5 m
DSM 5 pt/m2
orthophoto 0.5 m
GPS (ratrac, scuter)
2 hours field check
DTK5
DEM 0.5 m
DSM 10 pt/m2
orthophoto 0.1 m (april)
MTBO map
DEM 0.5
OP 0.1 m
(april)
2 hours
(tracks)
Conclusions

- Airborne laser scanning data are useful, but procedures for managing point cloud data should be improved.

- Good pre-processing can significantly improve results; some guidelines are needed.

- The ridges and ditches can be extracted from high-resolution DEM with existing tools, manual corrections are still needed though.

- The workflow for roads and paths extraction needs improvements: extracting more line segments and connecting them, adapting parameters of edge detection tools in respect to relief of local area.

- Automated updating of DEM is possible only for DEMs from the same sources.
Acknowledgment: The part of research was done under the target research project “Combined high-resolution procedures to capture, recognise and update spatial data”, financed by Slovenian Research Agency and Slovenian Surveying and Mapping Authority.