Recent research on 3D modelling of cadastral data in Slovenia

Jernej Tekavec, Anka Lisec, Miran Ferlan
University of Ljubljana,
Faculty of Civil and Geodetic Engineering
jernej.tekavec@fgg.uni-lj.si, anka.lisec@fgg.uni-lj.si, miran.ferlan@fgg.uni-lj.si

Introduction and related work

Traditional ways of defining a real property unit in the 2D space are becoming increasingly challenging. If the land administration system wants to follow the needs of the society, it has to support not only horizontal, but also vertical division of real property units (Stoter 2004, Paulsson 2007, Aien 2013, van Oosterom 2013).

Here we present the existing data and initial efforts in 3D modelling of Slovenian cadastral data. This presentation is limited to LoD 1 (Level of Detail 1) 3D models as defined in the CityGML standard (OGC CityGML 2008).

3D modelling of spatial data has been the subject of many research activities. Many countries are developing and implementing 3D cadastral models (van Oosterom et al. 2011, Stoter et al. 2013, Drobež et al. 2016, Kitsakis et al. 2016). While the CityGML standard is not suitable for the complete 3D cadastral data model (El-Mekawy and Östman 2012), the usability of CityGML for cadastral purposes has been investigated in multiple studies. They show that it can be adapted to land administration needs due to its flexibility and extensibility (Dsilva 2009, Çağdaş 2013, Gozdz et al. 2014).

3D building reconstruction

There are multiple ways of LoD 1 building height determination. Apart from maximum, there are also average and median heights. They can easily be obtained from the combination of a building footprint and LIDAR point cloud data. The LIDAR point cloud can also be used to control the coincidence with cadastral height attributes (i.e. photogrametric acquisition) to detect and later examine any possible errors. We used Safe Software's FME Desktop for processing and evaluating the results. The processing chain is summarised below.

- **LIDAR point cloud separation on ground points and other points**
- **Intersection of non-ground points with footprints**
- **Average point cloud height calculation**
- **Ground surface creation and intersection with footprints**
- **Calculation of the average building height**
- **Extrusion of the footprint ground surface with the building height**
- **Writing objects in CityGML class Building**

Methods and materials

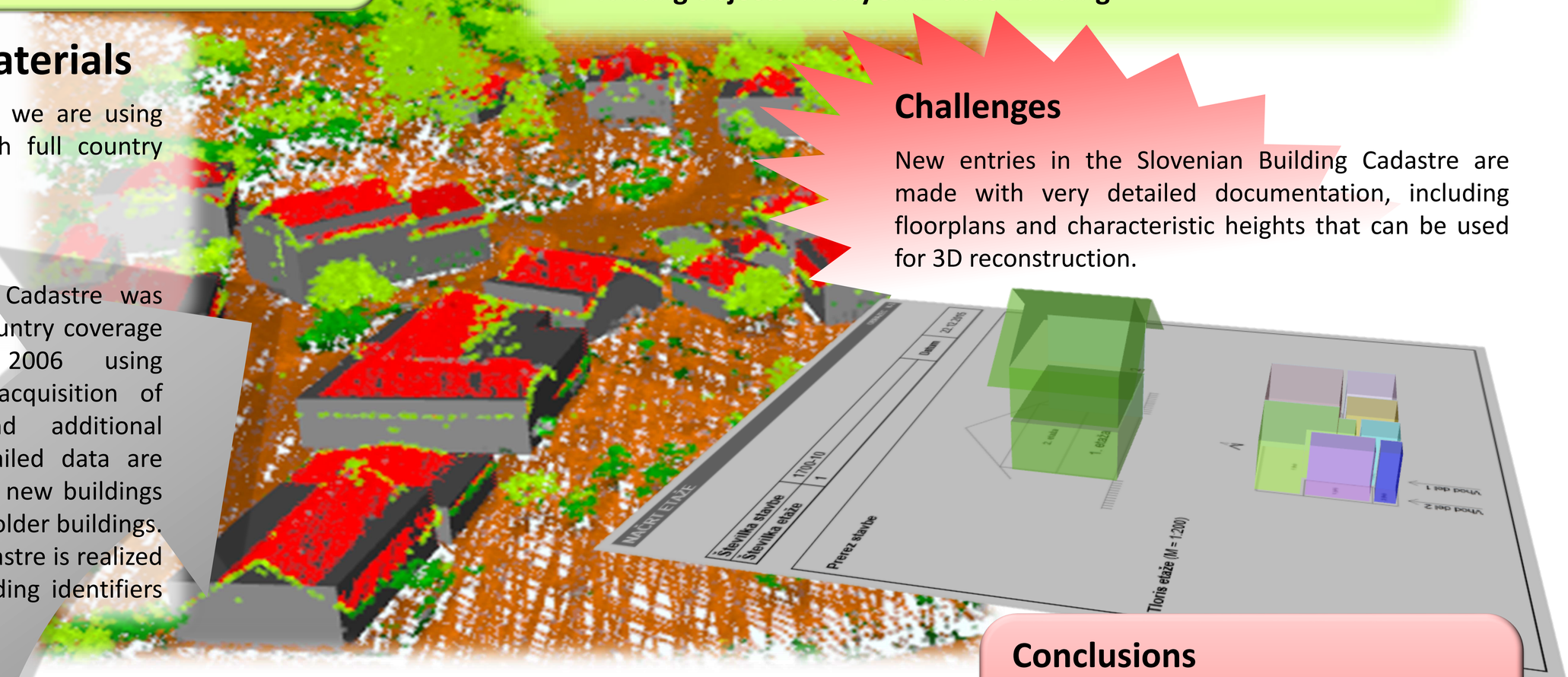
For the 3D reconstruction, we are using two national datasets with full country coverage:

• Building Cadastre

In Slovenia, the Building Cadastre was introduced in 2000. Full country coverage was established by 2006 using photogrammetric stereo acquisition of buildings' footprints and additional attribute data. More detailed data are required for registration of new buildings or new cadastral entries of older buildings. Connection to the land cadastre is realized using land parcel and building identifiers (Drobež 2016).

• LIDAR point cloud

The project Laser Scanning of Slovenia was completed in 2015. The classified point cloud is freely available for the whole country with a point density of 5 points/m2. Mountain and deep forest areas are scanned with a density of 2 points/m2, while some flood and landslide risk regions with 10 points/m2.



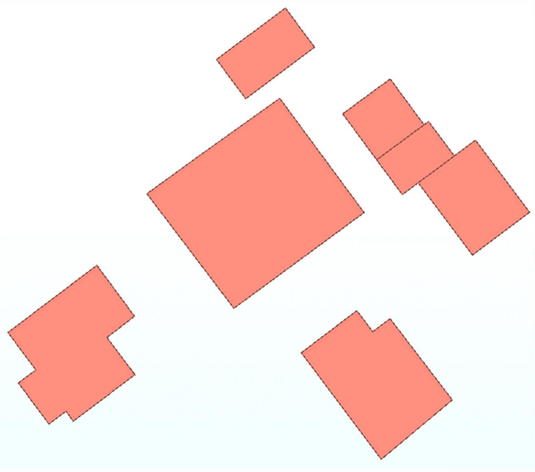
Challenges

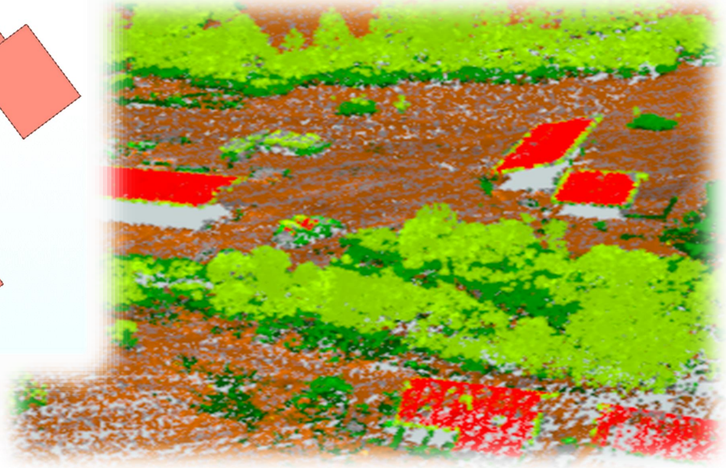
New entries in the Slovenian Building Cadastre are made with very detailed documentation, including floorplans and characteristic heights that can be used for 3D reconstruction.

Results

We successfully tested our method on a small dataset.

- **Results can be viewed in a software that supports the CityGML format.**
- **We imported objects into 3DCityDB running on the PostgreSQL database.**
- **Every object has a unique identifier and can be linked with other cadastral data in the database.**
- **The time needed for reconstruction mostly depends on the point cloud density.**





Conclusions

This 3D reconstruction approach illustrates the first step towards the physical implementation of a 3D cadastre in Slovenia.
We are investigating the possibilities of linking attribute data from the real property database (database for taxation purposes based on cadastral data) with 3D models. For this purpose, parts of the buildings have to be modelled in the 3D environment (real property units), which is another challenge for future research.

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