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LADM-based Crowdsourced 3D Cadastral Surveying – Potential and Perspectives

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Introduction

- **Current Situation:**
  - Vertically growing cities
  - Complex infrastructure
  - Subdivision of three-dimensional (3D) space
  - Overlapping property rights

- **Land Administration Domain Model (LADM ISO 19152)**
  - Spatial domain standard
  - Flexible conceptual schema for 2D/3D Cadastres
  - Based on a Model Driven Architecture (MDA)

The identification of the acceptable 3D geometries and representations for the 3D cadastral objects is still challenging
3D Aspect of LADM

- **3D LADM-based country profiles:**
  - Russian Federation
  - Poland
  - Korea
  - Greece
  - Malaysia

- **Linking LADM with physical models:**

**High demand of required time and cost**

- **Legislation**
- **Cadastral background**

**Legal data model**

- **Application schemas**
- **Technical models**
  - CityGML, IndoorGML, BIM/IFC, LandXML, InfraGML, etc.
The potential use of crowdsourcing for 3D cadastral surveys

- **Current research trends:**
  - Low-cost equipment & IT tools
  - Crowdsourcing techniques
  - Mobile services (m-services) & Web services
  - Open-source software (OSS)

- **Crowdsourcing in 3D cadastral surveys:**
  - Parametric modelling methods (Model-driven) – *Best Fitted Solution*
    - high robustness, maintenance of topology
    - can be adopted by parties without specific photogrammetric skills

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*A fit-for-purpose 3D crowdsourced cadastral surveying approach based on standardized data model as LADM, might be of significant value to speed up processes for establishing 3D cadastres*
Proposed Framework

Technical Aspects

Server-side

LADM-based DBMS

Client-side

Open-sourced mobile application for Android

Crowdsourcing Procedure

- Cost-effective LADM-based technical solution
  - Acquisition
  - Registration
  - 3D modelling
  - Visualization
Database Management System (DBMS) (2/2)

3D – Crowdsourcing Self-developed Mobile Application (1/2)

- **Self-developed open-sourced** Mobile Application
  - 3D cadastral data acquisition
  - 3D modelling of real properties (LoD1) 
    - Land Parcel & Property Unit → Model-driven approach
  - 3D visualization above & below the terrain

- **Software tools:**
  - Visual Studio 2013 (IDE)
  - Oracle JDK 8 (Java Development Kit)
  - Android SDK Manager (for API level 19),
  - add-in ArcGIS Runtime SDK for .NET (100.0.0) of ESRI
  - add-in Xamarin 4.5.0
  - the SharpKML library
  - the programming language of C#
  - the Server of ArcGIS Online (Cloud of ESRI)
3D – Crowdsourcing Self-developed Mobile Application (2/2)

Proposed Procedure for 3D Cadastral Surveys (1/2)

- Provision of the available **base map** with the areas under cadastral survey
  - recent **orthophoto** overlaid with buildings **floor plans** → **Higher geometric accuracy**
  - or
  - Orthophoto or aerial photo with the areas under cadastral survey → **Lower geometric accuracy**

- Crowdsourced 3D cadastral information/data acquisition
  - **Cadastral Mobile Application**
    - Demarcation / digitization of the property boundaries
    - Insertion of **additional geometric information**: building height, floor
    - Insertion of **additional descriptive information**: rights holder's personal data, type of rights, etc.
    - Verification **images** and **legal documents**
    - **3D Parametric reconstruction** of the building
Proposed Procedure for 3D Cadastral Surveys (2/2)

- Crowdsourced 3D cadastral information/data acquisition
  - Cadastral Mobile Application
  - Help needed?
    - Provided either by volunteers or by professionals
    - Demonstration videos of the mobile/web applications by NCMA

- Data evaluation and control by the cadastral service

- Compilation of preliminary crowdsourced 3D building models by right holders

Case Study (1/4)

 Acquisition of Crowdsourced 3D cadastral information/data:

- The room-outline coordinates
- The building area code, address
- The room holder name, role, type of rights
- The room floor, height, use, area size, volume

 Basemaps:

- Orthophoto at the scale of 1:1000
- Floor plans of:
  - the underground floor
  - the ground floor
  - the first and
  - the second floor at a scale of 1:200
Case Study (2/4)

- Registration procedure:

Case Study (3/4)

3D Visualization of the declared properties - LoD1 (Parametric Modelling)

Case Study (4/4)

- **Result evaluation:**
  - Comparison with the reference data:
    - Maximum deviation: 0.49 m
    - Minimum deviation: 0.03 m
    - Average deviation: 0.17 m
  - Qualitative 3D models
    - correct 3D position
    - small shape defects
  - Recording time per property:
    - 5-7 min fast
  - Easy-to-use
Conclusions

A cost effective solution is required for the initial implementation of a EU desired 3D Cadastre

- Modern Approach - 3D Cadastral Surveys:
  - 3D Crowdsourcing Techniques - Citizens' participation – errors minimization
  - Cost effective and time consuming solution / automation
    usage of modern low-cost IT tools, m-services, parametric modelling techniques
  - Land Administration Domain Model (LADM ISO 19152)
  - Available cartographic infrastructure

Generalized technical framework for the initial registration of 3D crowdsourced cadastral data and the creation of a standardize cadastral database for both the developed and developing world

Thank you for your attention!

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