Presentations “Application focusses, Point Clouds and Photogrammetry”

Data quality assessment of UAV-based products for land tenure recording in East Africa.

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Since the past two years, unmanned aerial vehicles (UAVs) are evolving as a mapping tool in African countries. However, conditions for flying, controlling and referencing respective data are more complex than in Europe and are often underestimated. Especially geometric accuracy and radiometry are negatively influenced by densely populated areas and adverse meteorological conditions. More than 40 datasets from 8 UAV field campaigns and demonstrations in Zanzibar, Rwanda and Kenya are used to conclude findings on opportunities and challenges to achieve high levels of data quality. The research is associated with the EU H2020 project “its4land”.

Unsupervised semantic change detection in informal settlements using UAV imagery

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The detailed spatial data obtained from Unmanned Aerial Vehicles can shed light on subtle changes in informal settlements which may be linked to important socio-economic developments in the area. For example: the creation of new roads, building extensions, and incremental improvements in roof quality.

Typical challenges for change detection methods include the detection of irrelevant changes through unsupervised methods, and training data requirements for supervised change detection methods. We therefore illustrate a workflow which combines rule-based, deep learning approach, and unsupervised change detection algorithms to develop an automatic workflow which identifies changes in informal settlements and assigns semantic meaning to them

Figure 1: RGB imagery of an informal settlement in Rwanda (left column), rule-based class predictions (middle column) and predicted class label (right column) for UAV data from 2015 (top row) and 2017 (bottom row). Red indicates buildings, beige indicates terrain, green indicates trees, and white indicates low vegetation.

Monitoring and forecast of crop water requirements and water use: highlights of the MOSES project

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The main objective of MOSES project is to put in place and demonstrate at the real scale of application an information platform devoted to water procurement and management agencies to facilitate planning of irrigation water resources. The operational use of dense time series of multispectral imagery (Landsat 8 and Sentinel 2) at high spatial resolution, in combination with weather short term predictions, makes monitoring and forecast of crop water requirements across the growing season feasible, with suitable temporal and spatial resolutions. The experience of MOSES project is discussed with particular attention to the adequacy of water applied to the actual water use and requirements.

Radar Remote Sensing for Crop Mapping: First Aid or Definitive Care?

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So far, Radar data have been mostly used in land applications as an all-weather surrogate of optical imagery. However, it is well known that microwave illumination reveals complementary facets of crops. A correct interpretation of the backscatter fluctuations is deemed to pave the way to a synergic in-season mapping of the phenological and water conditions of crops. Leveraging on this rationale, our research focused on assimilating the C-Band Sentinel-1 data to the optical time-series through a simple but functional Bayesian network in order to track the crop status and the land cover changes in near real time.

Building Roof Outlines Extraction from Airborne LiDAR Point Cloud using Hough Transform

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Detecting of building boundaries is essential for any urban mapping application. Researches on the extraction of building outlines are still carried on to accommodate the demand of faster processing with reliable result. Hough transform is widely known as an effective procedure to extract line features from the image. We investigate the Hough transform principles and propose a new approach to extract building roof outlines from LiDAR point cloud. The detected building outlines is appointed based on the voting scheme in Hough (θ, R) space. We invented some strategies to derive accurate building outlines and overcome a possible wrong line detection by using point accumulator matrix that contain a list of points.

Estimation of biodiversity relevant forest structure parameters using a multi-sensor and multi-scale remote sensing approach

Kalkidan Mulatu, Mathieu Decuyper, Benjamin Brede, Lammert kooistra, Brice Mora, Johannes Reiche, Martin Herold

The role of forest structure on regulating the microclimate, thus the biological diversity of tropical forest environments is proven essential. Our study aims to assess the variation of biodiversity relevant forest structure parameters along four forest types, and to derive satellite remote sensing (SRS) based predictors to estimate field measured structural parameters. We used a combination of conventional forest inventory (CFI) measures and Terrestrial Laser Scanning (TLS) to estimate forest structural parameters in tropical montane cloud forest in Kafa, Ethiopia. Using TLS it was possible to capture the forest structure variation along four forest types. Models from the combination of SRS derived variables were used to assess their ability towards estimating field measured forest structure parameters. Our results demonstrate that accounting of biodiversity relevant forest structural parameters at multiple scales require integration of multi-sensor remote sensing approaches.

Optimal Configuration of Scanners Mounted on Backpack Indoor Mobile Mapping System

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On average, people spend more than 80% of their time indoors and, therefore, mapping interior environments is in high demand. The overall objective of the research is the development of a backpack indoor mobile mapping system (BIMMS) that maps building interiors based on Simultaneous Localization and Mapping (SLAM). The configuration of the backpack system consists of three TOF laser range finders and an inertial measurement unit (IMU). Currently, I am looking for the optimal scanners' configuration. Therefore, different configurations of the scanners were selected, and a building was chosen carefully to serve as a test area.

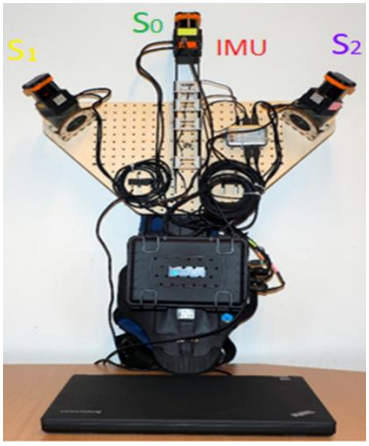

Fig . The used laptop and the backpack system (BIMMS) mounted by four sensors: three scanners S0 (Top), S1(left), and S2(right) and Xsens IMU (below S0)

The necessity of an extended error model for AHN

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With more than 315 publications citing *Actueel Hoogtebestand Nederland* (AHN) since 2014*, its release into the open domain can be considered a success. This highly detailed point cloud of the Netherlands is provided with an error description of a "5 cm systematic and 5 cm stochastic error, 1σ" per point.

All research based on or using AHN has to tackle the same problem first: how to interpret this error description. Although the data is validated against the error description before publication, the error description is in some cases unsatisfactory to describe the data. With simple examples unexpected behaviour of the AHN point will be shown. An extended error model and validation project is required to truly represent the variations in such an extensive point cloud.

UAV Laser Scanning for Geometric Tree Modelling in Forestry

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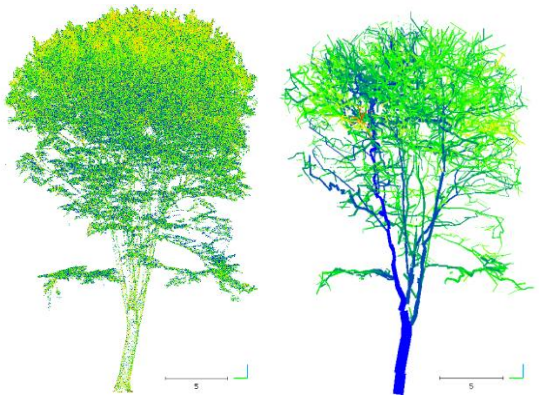
Recently, UAV laser scanning (ULS) has become available that produces ultra-high density point clouds (>1000 points/m^2) on local plots. This is an interesting data source for fast precision forest inventories. We tested ULS on a 200x100 m forest plot with 5 canopy structural types in comparison with Terrestrial Laser Scanning (TLS). From both datasets explicit geometric tree models from 129 individuals were derived and compared. First results show generally good correlation, but also the need for new quality measures for model tuning.

Keywords: *Forestry, UAV laser scanning, tree geometric modelling, biomass*



Integrated approach of change detection and update on Airborne LiDAR data using VHR images

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Up-to-date 3D city models are needed for many applications, especially for disaster management. Airborne LiDAR data is intensively applied for automatically reconstruction in decades. However, extracting edges from LiDAR is still problematic due to its various point densities and multiple returns near edges from roofs, walls and ground. More importantly, LiDAR is expensive and can only be updated in many years for state- and national- wide. VHR images often update annually are increasingly used for reconstructing up-to-date 3D models. However, the dense point clouds reconstructed from VHR images is often affected in shadow, low-texture and occlusion areas. Change detection between LiDAR data and images is a certainly better approach in order to keep the LiDAR point clouds in the unchanged areas and update the points with image point clouds in the changed areas. Considering the quality problem embedded in two data resources, we propose an integrated approach by utilizing good characteristic of both to compensate the quality problem of both. The method is split in two steps: 1) change verification by edge awareness dense image matching from LiDAR supervision. 2) change propagation and update by hierarchical dense image matching. In the first step, LiDAR data is used to limit the disparity search space (DSS) for images to better find their stereo pairs in problematic areas. A edge awareness MRF model is designed for dense image matching to choose the best disparity for image pairs. The stereo-pair found with very little color difference are identified as no changes and the correspondent LiDAR points in the no change areas are preserved. The partial changes are derived from high color difference stereo-pair due to homogeneity and shadow areas. By iteratively expanding the partial changes with one meter, a hierarchical dense image matching is performed in these areas until the disparity is the same with the disparity from LiDAR supervision. In the change areas, the correspondent LiDAR are discarded by replacement of the image point clouds. The experiment is performed in Amersfoort areas and compared with the other two methods, two DSM subtraction and two true ortho subtraction. The result shows our approach outperforms significantly than the two other two.

Automated photogrammetry of outcrops with MicMac

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Every year students from the TU Delft Bachelor Applied Earth Science have a geological fieldwork in Southern France. They map geological outcrops, but back in the Netherlands, it is difficult for them to check their work. When they have access to a 3D model database of the outcrops in the field it is possible to get an idea before the fieldwork and to verify their made maps. To create this 3D model database, an open-source photogrammetry program MicMac is used. An acquisition protocol and an automatic command-line script for processing student's images is developed. First results show that the workflow works well on smartphone and hand-held camera photos with GPS tags, while drone photos gave some problems.

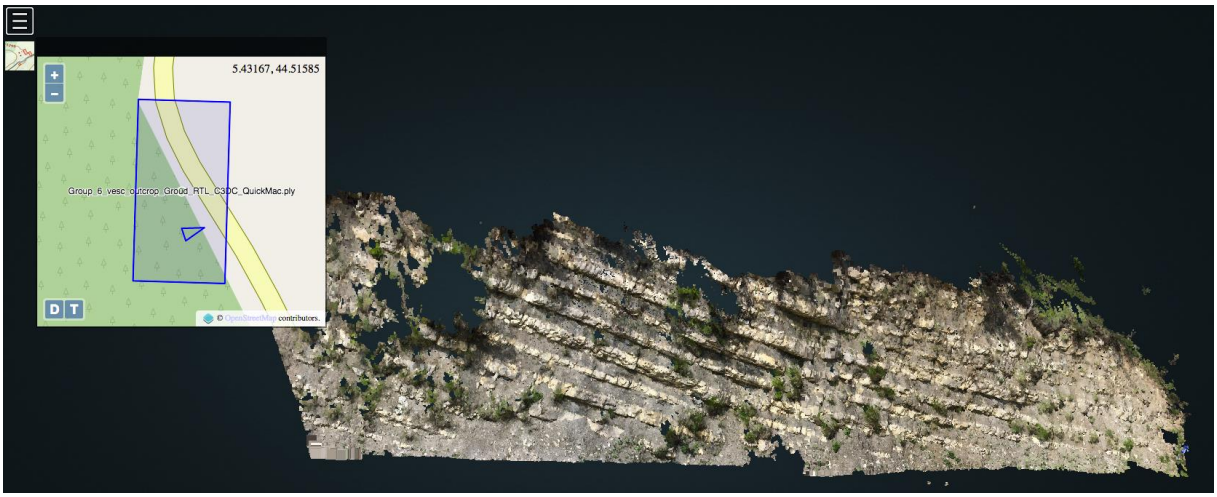

Figure 1: Result of photos from students

Towards Automated Cadastral Boundary Delineation from UAV data

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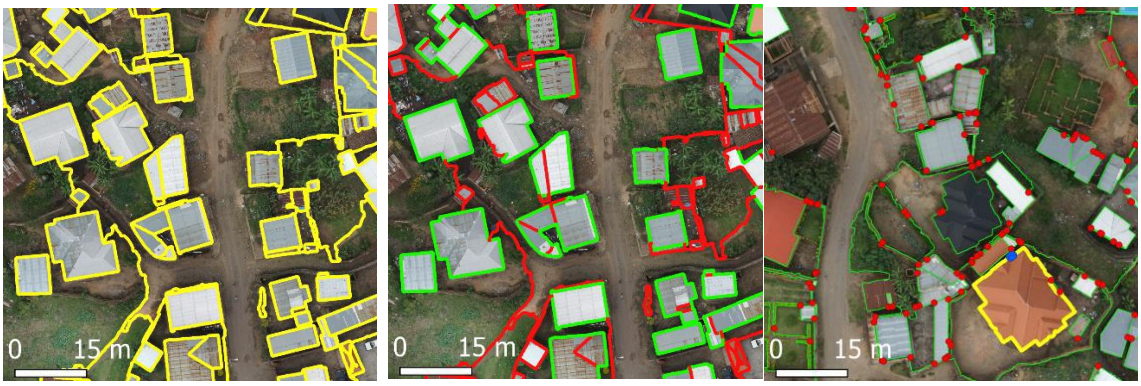
Abstract:
This PhD research aims to design and implement a method to facilitate land rights mapping through indirect surveying techniques from UAV data. It is based on the assumption that a large portion of cadastral boundaries is physically manifested through objects such as hedges, fences, stone walls, tree lines, roads, walkways or waterways. Those visible boundaries bear the potential to be extracted with methods from photogrammetry, remote sensing and computer vision. The automatically extracted outlines require further (legal) adjudication that allows incorporating local knowledge from a human operator. The method currently being designed and developed within this PhD research aims to provide a delineation approach that includes this automated extraction combined with an interactive delineation (Figure 1). This work is part of the Horizon 2020 program of the European Union (project its4land).



(a) (b) (c)

Figure 1. Object delineation approach: **(a)** MCG **image segmentation**. **(b) boundary classification** that requires line labeling into 'boundary' (green) and 'not boundary' (red) for the training data. The labelled lines are used together with line-based features to train a Random Forest classifier that generates boundary likelihoods for the testing data shown in (c). **(c) interactive delineation** guided by a the 'BoundaryDelineation' QGIS plugin to create a least-cost-path (yellow) between user-selected nodes (blue) taking into account the lines created in (a) and the boundary likelihoods generated in (b).

Utilising aerial oblique imagery to solve mobile mapping positioning issues in GNSS-denied environments

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Unlike aerial surveys, mobile mapping (MM) campaigns are directly affected by GNSS multipath and non-line-of-sight effects in particular in typical acquisition areas of MM, such as urban areas. Consequently, the accuracy of MM data products may be considerably reduced. To this end, a fully automatic approach based on the registration of MM and aerial oblique images has been developed. Whereas previous methods relied on aerial nadir images and were thus limited to ground-based features, such as road markings, aerial oblique imagery can harness building façades (see **Fout! Verwijzingsbron niet gevonden.**) to increase not only the number of correspondences but also further their vertical distribution, which is beneficial from a bundle adjustment perspective.