Abstracts

Sensor systems:

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Presentation title: **Comprehensive Comparison of 3D Point Clouds Data Derived from Aerial Photos and Airborne LiDAR for Large-scale Mapping**

The integration of computer vision and photogrammetry to generate three-dimensional (3D) information from stereo image matching has contributed to a broader use of point clouds. The image matching method is believed to have the ability to generate reliable and detailed point clouds as LiDAR. There is two popular image-matching methods to generate point clouds, which are Semi Global Matching (SGM) and Structure from Motion (SfM). Different mapping purposes may require different point cloud data specification. Thus, it is important to select the point cloud data that suitable for a specific application. In order to conduct the comprehensive and fair comparison, this study uses LiDAR and aerial photos data that were acquired at the same time. The qualitative and quantitative comparison has been conducted to evaluate LiDAR and image-matching point clouds data regarding the visualization, geometric accuracy, and classification result.

Registration free methods for detecting changes in terrestrial laser scan data

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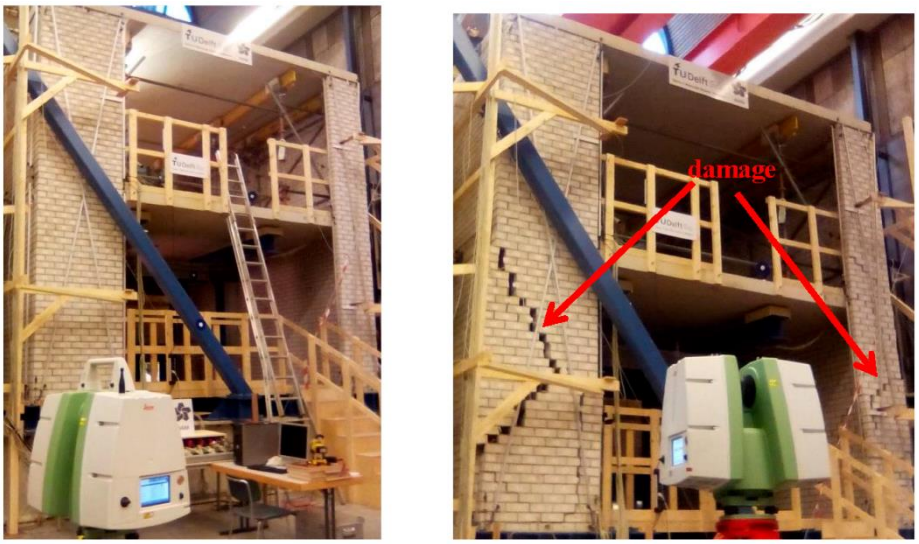

Figure 1: Lab induced damage measured by Terrestrial Laser Scanning

Buildings in the Dutch province of Groningen were not designed to withstand earthquakes, but in recent years were facing seismic activity. To assess their structural behaviour, house like constructions wer were monitored in the TU Delft Stevin Lab during increased induced stress conditions. One way of monitoring was terrestrial laser scanning, compare Figure 1. Typically, scans obtained at different times are aligned in a common coordinate system, a processing step referred to as registration. Unfortunately , a registration step will also add to the error budget of a workflow, which may significantly affect the result in case of low signal to noise ratio's. In the presentation, two registration free approaches will be discussed, designed for the 2016 and 2017 lab tests, respectively.

Reference

Change Analysis in Laser Scanning Point Clouds: The Baseline Method (2017), Yueqian Shen, Roderik Lindenbergh, Jinhu Wang, Sensors, 17(1), 26; doi:10.3390/s17010026

Name: Claudia Stöcker, Francesco Nex, Mila Koeva, Rohan Bennett, Jaap Zevenbergen

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Presentation title: **Towards UAV-based Land Tenure Data Acquisition**

The realm of land administration is currently being challenged: conventional western-oriented land administration systems have mostly failed to supply their expected results in developing countries. Amongst others, unmanned aerial vehicles (UAVs) are evolving as a tool for alternative land tenure data acquisition approaches. However, major bottlenecks such as regulatory frameworks and time-consuming ground truthing are issues currently hindering large-scale implementation. This study sheds light into the design process of UAV-based data acquisition workflows and reveals results of initial field tests in Rwanda and Germany. Insights of operational challenges and data quality measures will be presented. The research is associated with the EU H2020 project "its4land".

Figure 2:

Conceptual framework

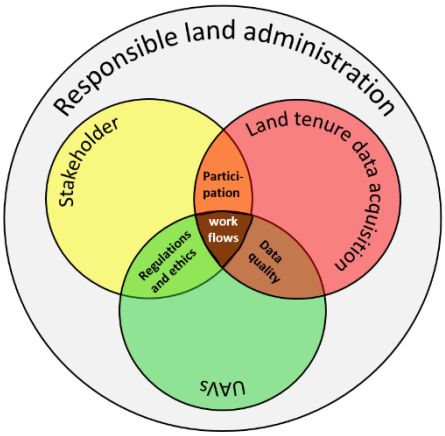

Figure 2:

UAV-based Orthomosaic (Busogo/Rwanda)

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Presentation title:
Is Citizen Environmental Sensing Valuable?

Abstract (~100 words and optionally 1-2 figures):
Citizens initiate or participate in science has existed for a long time. Mostly, citizens are involved in data collecting. Due to the technology development, environmental sensors are becoming smaller, cheaper and more advanced. This brings more opportunities to citizens to conduct environmental monitoring. Especially when they are not satisfied by official environmental monitoring data. However, is it difficult for citizens to create/use sensor devices to monitor the environment? Is this citizen environmental sensing valuable? Can citizens rely on the data produced by themselves using these sensors? How experts think about these data? According to the case studies conducted in Amsterdam and a perceptions survey of experts and citizens, the citizen environmental sensing data is expected to complement official data. However, due to still largely unknown accuracy and other hurdles, citizen environmental sensing is still far from fulfil its potential.

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Presentation title: **Tree bark roughness index by Terretrial LiDAR**

Vegetation structure parameters are key elements in the study of ecosystem functioning and global scale eco-systemic interactions. Tree bark roughness is crucial to determine the stemflow volume and solute inputs. Moreover, interspecific variation in bark morphology will affect the bark water storage capacity, influencing the plant water balance.
Due to the increasing use of TLiDAR (Terrestrial LiDAR) for forest inventory, the development of software tools and methodologies to automatically measure tree attributes from PCD (Point Cloud Data) is urgently required. To the best of our knowledge, no research has been done to automatically compute a roughness index of the tree bark by PCD.
In this research, a method to derive a roughness index for individual trees based on the PCD analysis of the bark coming from TLiDAR is proposed. Differences among trees and species were studied. Results are still being evaluated, with particular attention to the completeness, quality and density needed for the Point Cloud Data (PCD) of the tree trunk required to apply our approach.

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Presentation title: **6DOF Simultaneous Localization and Mapping using 2D Laser Range Finders and IMU**

On average, people spend more than 80% of their time indoor and, therefore, mapping interior environments is in high demand. The aim of this 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 BIMMS consists of three 2D scanners (Hokuyo UTM-30LX) and an Inertial Measurement Unit (Xsens MTi-300) mounted with a special configuration (see figure 1). The developed BIMMS has been utilized to map one conventional building at Braunschweig University, Germany, and the results are shown in figure 2.

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Presentation title: **SuperGPS**: **Accurate timing and positioning through an optical-wireless distributed time and frequency reference**

GPS has an excellent proven track record, and a huge economic value, but at the same time, GPS, as well as other GNSSs, has a number of limitations, think of reduced sky-visibility in a built-up area, multipath and susceptibility to interference. Hence, we propose a novel hybrid optical-wireless terrestrial system for accurate positioning through a grid of terrestrial radio transmitters, which are synchronized through an optical telecommunications network. By using (ultra) wideband radio signals, as opposed to relatively narrowband GNSS signals, this hybrid optical-wireless terrestrial radio system will be suited for accurate positioning in built-up areas, including tunnels and urban canyons.

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Presentation title**: Application of satellite and UAV based thermography for soil salinity assessment**

An increased soil salinity is one of the severe land degradation factors and up to date soil salinity information is vital for appropriate management practices and reclamation strategies. The canopy temperature change is one of the stress indicators in plants which can be easily measure by remote sensing tools. The study areas were Syrdarya province of Uzbekistan, four study areas in Australia and test field in the Netherlands. Temperature of wheat, cotton, barley and quinoa were analysed. Significant relations between the soil salinity maps and canopy temperature were discovered. The canopy temperature differences varies for different crops, but the trend of temperature increase under increased salinity is present in all cases. And quinoa showing the less conclusive results of all. Most likely because of its salt tolerance. Satellite thermography appeared to be a valuable approach to detect soil salinity under agricultural crops at landscape scale.

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Presentation title: **Generating hight-temporal and spatial resolution TIR image data**

Abstract (~100 words and optionally 1-2 figures):
Remote sensing imagery to monitor global biophysical dynamics requires the availability of thermal infrared data at high temporal and spatial resolution because of the rapid development of crops during the growing season and the fragmentation of most agricultural landscapes. Conversely, no single sensor meets these combined requirements. Data fusion approaches offer an alternative to exploit observations from multiple sensors, providing data sets with better properties.
A novel spatio-temporal data fusion model based on constrained algorithms denoted as multisensor multiresolution technique (MMT) was developed and applied to generate TIR synthetic image data at both temporal and spatial high resolution (Fig.1). Firstly, an adaptive radiance model is applied based on spectral unmixing analysis of TIR radiance data at TOA (top of atmosphere) collected by MODIS daily 1-km and Landsat/TIRS 16-day sampled at 30-m resolution are used to generate synthetic daily

radiance images at TOA at 30-m spatial resolution. The next step consists of unmixing the 30 m (now lower resolution) images using the information about their pixel land-cover composition from co-registered images at higher spatial resolution. In our case study, TIR synthesized data were unmixed to the Sentinel 2 MSI with 10 m resolution. The constrained unmixing preserves all the available radiometric information of the 30 m images and involves the optimization of the number of land-cover classes and the size of the moving window for spatial unmixing.

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Presentation title: **A FULLY AUTOMATIC SOLUTION TO ADJUST MOBILE MAPPING IMAGING DATA IN GNSS-DENIED URBAN AREAS**

Terrestrial Mobile Mapping (MM) is able to augment the portfolio of existing geo-data acquisition techniques especially for applications in urban areas. High resolution data postings, however, have to be seen alongside a challenging positioning scenario. GNSS-based positioning accuracy directly depends on the unobstructed line-of-sight between the receiver and the satellite (Non-line-of-sight = NLOS). This requirement cannot not always be fulfilled in urban areas.

In order to verify and correct the position of MM platforms, usually surveyed Ground Control Points are employed. As this procedure is impractical for large data sets as well as labour-intensive and expensive, an array of different approaches has been developed to tackle aforementioned positioning issues. Shadow matching (line-of-sight modelling), procedures based on Simultaneous Localisation and Mapping, Visual Odometry etc. show promising potential, and are to some extent real-time capable. Since these techniques do not necessarily utilise external reference data, adjusted MM data cannot maintain a consistent accuracy presupposed for surveying-grade mapping tasks.

Both requirements, automation as well as a high accuracy can be met by utilising airborne imagery as the source of reference data. Firstly, airborne images do not suffer from NLOS-induced positioning issues whilst offering highly-accurate data postings due to calibrated cameras and precise localisation instruments. Secondly, nadir and oblique aerial perspectives enable a complementary coverage of urban areas, and thus offer a mutual overlap with the MM images. Consequently, image observations of both platforms can be linked to enable an adjustment of the MM data.

The entire procedure is designed in a sequential manner according to the acquisition time of the MM images to exploit the high relative accuracy between adjacent images. This allows for the extraction of correspondences linking MM images along the trajectory which are used as relative constraints in an adjustment solution. Moreover, direct correspondences between MM and aerial data are identified by increasing the resemblance of the data sets, and by utilising phase correlation matching to overcome differing image properties.

Subsequently, linked MM and aerial image observations are integrated into a bundle adjustment solution. Since MM images are connected by individual tie points, not every MM image necessarily requires direct correspondences to the aerial data set. As this contribution will show, the adjustment returns satisfactory results ascertaining the feasibility of this approach. However, the distribution and the quality of direct correspondences is pivotal, thus the adjustment may potentially fail under certain circumstances. To this end, future developments will focus on the integration of airborne oblique

images not just to increase the number of correspondences but to allow for diverse observations as well.

This contribution outlines the entire procedure, places emphasis on the adjustment strategy, and presents experimental results in the city centre of Rotterdam.

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Presentation title: **Airborne LiDAR data filtering based on geodesic transformations of mathematical morphology**

The capability of acquiring accurate and dense three-dimensional geospatial information that covers large survey areas rapidly enables airborne light detection and ranging (LiDAR) become a powerful technology in numerous fields of geospatial applications and analysis. LiDAR data filtering is the first and essential step for digital elevation model generation, land cover classification, and object reconstruction. However, the filtering quality is generally sensitive to the selection of windows. Aiming to deal with the dependence on the selection of windows, we propose a new filter of LiDAR point clouds based on geodesic transformations of mathematical morphology. This algorithm makes it unnecessary to select different window sizes or determine the maximum window size, which can enhance the robustness and automation for unknown environments.

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Presentation title: **Fast Animal Detection in UAV Images using Convolutional Neural Networks**

Illegal wildlife poaching poses a severe threat to the environment, such as progression towards extinction of species like Black Rhino. Measures to stem poaching have only been with limited success, mainly due to efforts required to keep track of wildlife stock and animal tracking. In this work we aim at providing an efficient low-cost solution to detect large mammals using UAV imagery and state-of-the-art machine learning techniques like Convolutional Neural Networks. We showcase the efficacy of our model on a large set of UAV imagery, acquired over a wildlife park in Namibia, and are able to obtain promising detection accuracies at very high processing speeds.

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Presentation title: **Imaging spectroscopy from Unmanned Aerial Vehicles as a technique to scale from plant traits to ecosystem processes**

Different scientific disciplines are looking for effective methods to characterize plant functioning in both agricultural and natural ecosystems. However, quantifying plant traits at field/landscape level is time consuming and costly. Applying imaging spectroscopy from Unmanned Aerial Vehicles (UAV) allows innovative possibilities to assess traits at detailed spatio-temporal scale, allowing improved coupling of plant traits to ecosystem functioning. This allows to investigate relations and develop methods to retrieve plant traits from (a combination of) high-resolution imagery.
In this presentation, I will specifically focus on the added value of new sensing capabilities and associated analysis methods to characterize plant functional traits. This will be illustrated in several case studies ranging from biodiversity mapping in tropical rain forest (figure 1), flammability traits of heathlands in Scotland, and height and biomass mapping for 3000 small-scale maize plots in field phenotyping experiment.

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Presentation title: **Indoor positioning: Matching images and floor plan**

Accurate indoor positioning have a wide range of applications from first responders to marketing. We propose an approach to match the indoor images with the floor plan. This is a particularly challenging task due to different characteristics of images and floor plans. We solve the problem by applying Convolutional Neural Network (CNN) to image, classifying the scene, such as kitchen or lobby, and localize important features, such as windows and doors. The classified region is searched and the localized features are matched with their corresponding ones in the floor plan and consequently, the pose of camera is determined.

Figure 1: Indoor localization by matching the image and floor plan; the top image can be uniquely localized in the floor plan, but the bottom image is ambiguous and cannot be matched to the floor plan (Conference hall, Hokkaido University).

Lobby/Hall				
Door	1024	1044	1104	1121
Column	2123	110	2134	2019
Window	14	1140	275	968

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Presentation title: "**An Healthy Urban Route Planner**"

Cities are hotspots of air pollution and heat stress, the exposure to which results in nuisance, health risks, cost of medication, reduced labour productivity and sick leave for citizens. Our objective is to

raise awareness of heat and air quality issues in Amsterdam (NL) and provide citizens and tourists a tool to adapt to this. We developed a route planner, that proposes the most healthy routes in Amsterdam (NL), based on model simulations of weather and air quality. Emissions of traffic are mapped as input for a weather model at unprecedented grid spacing of 100-m, of which the output weather maps on its turn serves as input for a route planner that calculates, as alternatives to the shortest path, the more healthy route options on the route network of Amsterdam.
