UNMANNED AERIAL SYSTEMS IN THE
PROCESS OF JURIDICAL VERIFICATION OF CADASTRAL BORDERS

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Abstract
Quite often in the verification of cadastral borders, owners of the parcels involved are not able to make their attendance at the appointed moment in time. New appointments have to be made in order to complete the verification process, and as a result often costs and throughput times grow beyond what is considered to be acceptable. To improve the efficiency of the verification process an experiment was set up that refrains from the conventional terrestrial methods for border verification. In a novel approach the verification process relies on recent and accurate aerial photographs of the topographic situation of the parcel(s) involved, which show sufficient details and have a measurement precision of 6cm or less. In these aerial photographs the owners can verify the borders independently of each other. After reaching agreement between the owners, the pictures can subsequently be used to measure the cadastral borders with high accuracy.

The National Cadastral Services of the Netherlands "het Kadaster" actively seeks ways to innovate and improve their production process and increase its efficiency. During spring 2011 the Product Innovation Department of "het Kadaster" became aware of the potential application of mini-UAS in cadastral services. As "het Kadaster" had no previous experience with UAS and accurate Structure From Motion based photogrammetric processing techniques, an active cooperation was sought with the Dutch National Aerospace laboratory NLR. Jointly a plan for an operational test and evaluation of the technology and for experimenting with a number of relevant processing techniques was drafted. As NLR actively cooperates with the UAS departments of the National Netherlands Police KLPD and the subject of research shows significant overlap with the area of detailed crime scene registration, the KLPD responded positively on a request to join the experiments. The combined expertise and experience of the three parties provided an environment for rapid progress. In the execution of the operational tests and the processing of the resulting data, a thorough understanding of the relevant aspects and requirements on both the UAS operations and the processing software was formed. Subsequently, a commercial service provider for UAS based aerial photography based services was hired to generate a set of aerial images and provide a resulting ortho-photo. This provided a reference for comparison of the experimental activities with commercially available services.

The central research question of the overall cooperation was formulated as "How useful are Unmanned Aerial Systems in the juridical verification process of cadastral borders of ownership at het Kadaster in the Netherlands?"

For the experiment, operational evaluations were executed at two different locations. The first operational evaluation took place at the Pyramid of Austerlitz, a flat area with a 30m high pyramid built by troops of Napoleon, with low civilian attendance. Two subsequent evaluations were situated in a small neighborhood in the city of Nunspeet, where the cadastral situation recently changed, resulting from twenty new houses that were build. Initially a mini-UAS of the KLPD was used to collect photo datasets with less than 1cm spatial resolution. In a later stage the commercial service provider Orbit Gis was hired. During the experiment four different software packages were used for processing the photo datasets into accurate geo-referenced ortho-mosaics. In this article more details will be described on the experiments carried out. Attention will be paid to the mini-UAS platforms (Asctec Falcon 8, Microdrone MD-4), the cameras used, the photo collection plan, the usage of ground control markers and the calibration of the camera's. Furthermore the results and experiences of the different used SFM software packages (Visual SFM/Bundler, PhotoScan, PhotoModeler and the Orbit software) will be shared.

The current conclusion of the still on-going cooperation is that UAS are to be considered as realistic and useful systems for the juridical verification process of cadastral borders of ownership in the Netherlands. It has proven to be possible to produce ortho-photos with a geometric accuracy of 3cm, which is very promising for cadastral usage. Additionally, borders that are indicated on high resolution pictures made by an UAS can be indicated with at least the geo referential precision that is provided by conventional terrestrial surveying methods. However, further research is still necessary, on numerous areas. A detailed assessment of the juridical consequences of using ortho-photos made by UAS in the juridical
verification of borders of ownership is required, the costs of the new approach in comparison with conventional terrestrial process have to be determined, the procedures for operational application of the methodology have to be established, just to name a few.

Figure-1: Overview of produced orthophoto of Nunspeet.