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MAGAZINE FOR GEOSPATIAL TECHNOLOGIES

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COLOPHON

Publisher:
Lemarco
Sneeuwbeslaan 17 B7
B-2610 Wilrijk
+32 (0)3 827 26 36
contact@lemarco.be

Editorial:
Vicente De La Cruz,
Sarah Jones,
Johan Bonne,
Lomme Devriendt

Editor in chief:
Peter Bonne

Graphics :
Sweet Lemon

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EDITORIAL

Dear Reader,

In this edition of Orbit Magazine, we tell you about some highly topical and innovative stories taking place internationally. We are also able to present testimonials from some of our representatives who have achieved great results using Orbit technology.

We put forward the idea some years ago that the way in which data is gathered, surveying measurements taken and maps produced could accommodate two new technologies: mobile mapping and UAV mapping. Today, Orbit GT leads the way internationally in both areas. With these technologies, the proof-of-concept stage is long past and is now being applied extensively. You can read some of these testimonials in this issue of the magazine.

We wish you a pleasant read.

Peter Bonne

CONTACT US

ORBIT GeoSpatial Technologies nv
Industriepark E17, 2021
Scherpeputstraat 14
9160 Lokeren, Belgium

phone +32 9 340 5757
+32 9 340 5750
mail info@orbitgis.com
www.orbitgis.com

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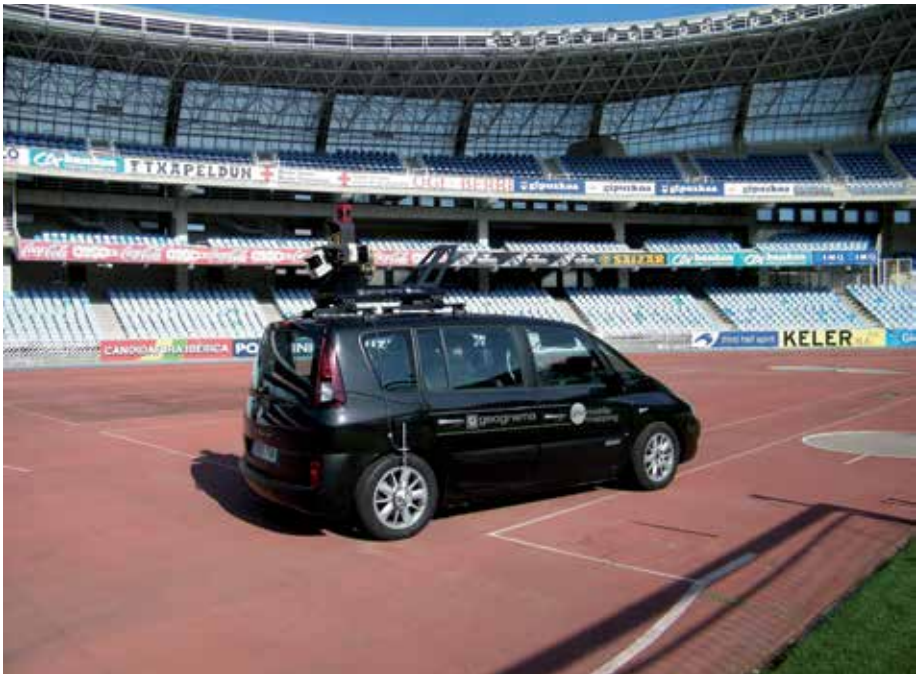


The Geograma mobile mapping vehicle, fitted with a Topcon IP-S2 system, scanners, panoramic camera, GNSS, IMU and odometer.

Tradition and modernity go hand in hand in this 'small' big city with touches of the Belle Époque (Golden Age) that has a top-flight cultural agenda with its international film and jazz festivals and its firstclass cultural programme.

Shaped by its history; it started out as a fishing village and grew as a market town and military fort, with the invasion by Napoleon's troops; and after being almost completely destroyed in 1813 by the garrison's battle against the Anglo-Portuguese, it was chosen by Queen Isabel II of Spain as the Royal Family's summer residence and began to flourish as a services city.

GIS San Sebastian

San Sebastian's Municipality has a GIS (Geographic Information System) that manages cartography at a scale of 1/500 for all the departments.

The Territorial and Town-planning Information Section (TTIS) depends on the Town-Planning Department and provides the geographic information required by the different municipal departments. From the land registry to the local police, including urban maintenance services, gardens and social mobility, a considerable variety of municipal users access the TTIS geographic database on a daily basis.

From the definition of alignments to the management of street furniture, including urban land registry and traffic management, the geographic information system has to provide precise and updated information so it can be used as support in decision-making.

Growing need of data

The need and demand of geographic information is steadily growing, thus requiring the use of new methods and technologies to register real data and offer the best available information to its users, whether internal or external, technicians or citizens.

As a result, a pilot project was defined with the aim of applying Mobile Mapping technology to urban inventories. An area of the city of Donostia-San Sebastian was delimited in order to obtain different types of information and therefore be able to contrast the technologies in a variety of situations. Both new construction and consolidated areas were defined.

Scanning the Street of San Sebastian

Geograma carried out the project, which consisted of photographing and scanning the streets. This added a large amount of graphic information to the GIS and improved the knowledge regarding the territory and the efficiency of the processes based on geographic information. The information was collected comprehensively, even restricted areas were accessed such as patios or accesses reserved for emergencies, and only seven data collection sessions where required - spending one or two hours per session.

Data collection was carried out using Topcon IP-S2. The field equipment simultaneously registered and controlled the information obtained. Spatial Collect and Geoclean software supplied by Topcon were used for both data collection and post-processing.

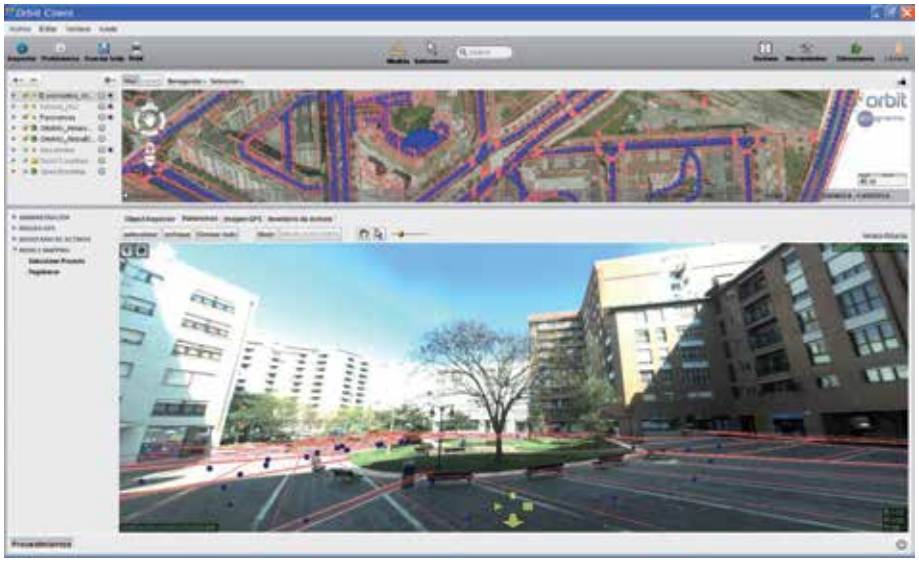
After the field data was collected, post-processing of raw data was carried out. This consisted of geo-referencing to the nearest GNSS base in order to obtain a precise location, composing 360º panoramic images and generating open formats of point clouds and photographs to simplify the import of data using specific tools, such as Orbit AIM3 software, with the aim of exploiting it.

The TTIS obtained the necessary information from this data and prepared inventories to improve urban planning information, base cartography and the cadastral plan.

In addition, the total solution simplifies the maintenance of these inventories, therefore ensuring the investment and increasing the efficiency and effectiveness of management.

Panoramic view of San Sebastian bay

Visualisation of a town inventory as a map and as a panoramic image



Visualisation of urban geodata as a map and as a panoramic image

Vicente de la Cruz
Mobile Mapping Manager
Geograma S.L.
C/ Castillo de Eskibel 2, Bajo
01007 Vitoria-Gasteiz, Spain
Tel.: +34 945 13 13 72
Mobile: +34 692 666 209
Email: geograma@geograma.com

www.geograma.com/en/
www.geomobilemapping.com/en/

ASSET MANAGEMENT: MOVING WITH THE TIMES

SARAH JONES EXPLORES HOW MULTI-DIMENSIONAL DATA ACQUISITION TAKES MOBILE MAPPING TO THE NEXT LEVEL

Mobile Mapping systems are designed and configured to collect highly detailed and commonly geo-referenced LiDAR and photographic datasets from vehicles travelling at highway speed. The achievable geo-referencing accuracies from sophisticated GNSS and inertial navigation systems enable professional end user applications ranging from mass GIS data capture through 3D modelling and detailed topographical mapping.

As with the mass market Google Street View product it is the power of the panoramic photographic imagery that renders the datasets accessible, intuitive and highly productive from a mapping perspective. Whereas the vast majority of professional users remain rather intimidated by a 3D LiDAR model alone, when the point cloud is combined with high resolution photographic imagery the power of the underlying geometrical model is unlocked allowing powerful 3D modelling and representation.

Not only does the photography remove ambiguity from feature identification but it provides an invaluable textural input to modellers, condition assessment to

LiDAR Point Cloud

High Resolution Panoramic Photography

Integrated LiDAR and Photography

asset managers and overall context to all. It is the human ability to instantly interpret and relate photographic data to reality that is so effectively leveraged with the mobile mapping approach. The mobile mapping system user may view geographically unique environments from any aspect and is now enabled to coordinate what they see. Mobile mapping technology provides fully geo-referenced models, in which coordination, measurement and modelling is as simple as pointing and clicking.

Regardless of whether the feature coordinates are derived from photo-grammetric or LiDAR aided techniques the essence of the mobile mapping system challenge is the ability to maintain accurate and robust 3D coordinates of the mapping platform, i.e. the survey vehicle. Without this assurance the value of the mapping sensors – whether photographic, LiDAR or other – are limited.

Breakthrough

Of course, ubiquitous GPS, or rather GNSS, is at the heart of the solution, providing not only high accuracy dynamic positioning but also a definitive timing reference. However, as all seasoned surveyors and GI professionals know, even with multiple-constellation, advanced signal processing GNSS receivers in a static mode the chances of maintaining accurate position within a built up environment are minimal. The real breakthrough with mobile mapping technology has been the augmentation of the GNSS solution with inertial navigation technology – the use of multiple accelerometers to determine positional change. Now the survey platform can maintain accurate position, and motion compensation, even while passing under such adverse GNSS environments as a bridge. What was until recently the reserve of specialist high budget mapping campaigns utilising custom-built vehicles with protracted mobilisation and calibration procedures, is now available as a commercially-viable tool for routine mapping projects.

A single data acquisition campaign at highway speed provides an exceptionally rich data-set, enabling data to be used for multiple applications by multiple users at multiple sites. The photographic core component of the data-sets enables multiple users - asset owners, operators, planners, surveyors, engineers, structural modellers, security advisors and maintenance teams - to all benefit from the single source of data.

The ability to derive substantial value from this homogenous dataset within a GI platform greatly supports asset management workflows. Mobile mapping enables exceptional rapid acquisition of fit-for-purpose data as an aid to the development of the asset management life cycle

LiDAR-aided GIS solution

ORBIT AIM3 software has been developed to extract the asset inventory data from the mobile mapping model. This is a GIS-based software package developed specifically for the extraction and GI management of asset data from photographic panorama data, recently enhanced to manage point cloud data embedded within the data-set. The technology has evolved over many years, however the introduction of a LiDAR aided solution, based on the Topcon IP-S2 system and format, has significantly increased the capability and productivity rates.

The software allows the user to view, inspect and extract from and overlay content within the mobile mapping model. Within the user interface the operator is equipped with the tools to select from map canvas, panorama, point cloud, measurement and table information to enable a project specific workflow. Assets within the model are, by definition, features commonly represented by points, lines or polygons. In addition to this symbolic representation the model allows for the capture of descriptive information which is managed through the user interface or directly within the database.

Metadata is also extracted for each feature alongside the x, y and z coordinate value. Generally within

ORBIT AIM3, user navigation within the model is of similar layout and process – panorama and map plan view – to Google StreetView, providing a most intuitive solution in maximising efficiencies. A new level of productivity for geodatabase population is achieved through the map point and click technique. This allows for rapid population of assets into a central spatial repository which can seamlessly integrate into existing back office asset management systems.

The advantage of the technology available is that it meets the challenges of a number of GI issues. That of

a) Integration – ORBIT AIM3 is a scaleable solution which is deployed either stand alone or in a client server configuration within organisations existing IT infra-structure / back office systems.

b) Interoperability – ORBIT AIM3 is a solution that supports open file formats namely ESRI shp file format for import / export.

c) Visualisation – enables greater multi discipline access to the measurement / data acquisition interface.

d) Promotes reuse and sharing of data amongst traditionally disparate functions.

Sharing is key!

It is the interpretation and the ability to provide location-based asset analysis, quantification and trend mapping from the captured data which built into the workflow, provides a useful tool for the asset manager. However, perhaps a more fundamental challenge is to provide this rich dataset in organisations where functions are often disparate and not transparent. So having captured the data, sharing it is key!

Attribute	Value
Object ID	802
Theme	NonIlluminatedSigns
Create Date	2012.03.22 13:02:51
Create User	User1
Last modified date	2012.03.22 13:06:31
Last modified user	User1
REF_ID	0
Annotation	
PoleType	2 Pole
X	-2.1745597194408885 (WGS84)
Y	53.02882706442515 (WGS 84)
Z	225.9567672828292 (WGS 84)

Within the mobile mapping GI extraction model the ability to serve an intuitive fully geo-referenced photographic, or video, model to a multi-disciplinary user base, which allows all users to take their own

accurate measurements, is an extremely powerful and cost effective tool. Data may be revisited time after time for further measurements or feature extraction.

LandScope have also deployed the mobile mapping system to various survey platforms including small survey and utility boats. Given that river banks, shorelines and ports and harbour environments are generally restricted access for traditional survey techniques, the mobile mapping system provides a versatile solution for mapping, asset inspection and asset capture.

Mobile mapping enables the asset manager with a rapid and accurate data acquisition tool in which the photographic core unlocks multiple applications to multiple discipline users at multiple sites. The spatial intelligence embedded within the photographic domain – from both LiDAR and photogrammetry – takes mapping to the next level.

Sarah Jones, Manager GI Services,
LandScope Engineering Ltd

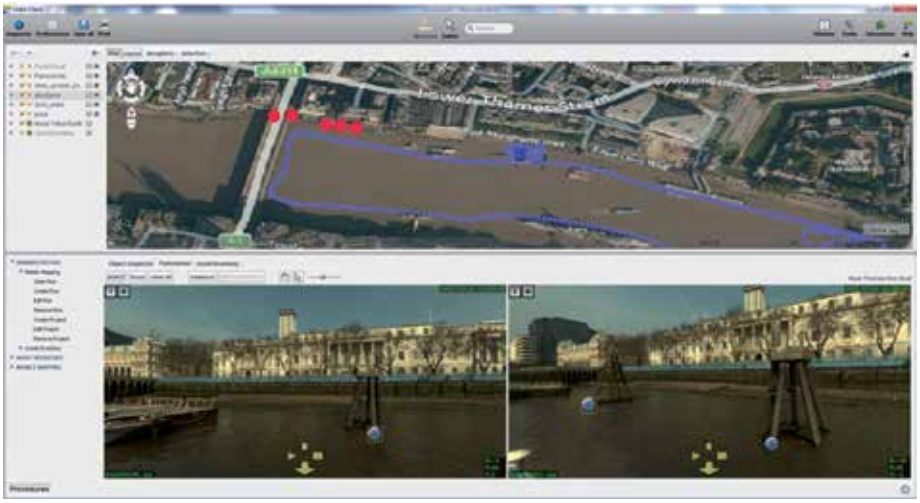
The Chart House, Picklescott,
Church Stretton, Shropshire, SY6 6NT,
United Kingdom

Tel: +44 (0) 1694 731930
Fax: +44 (0) 1694 751343

Email: enquiries@auto-map.co.uk
Web: www.auto-map.co.uk

Topcon IP-S2 System – incorporating 360° Camera, IMU, GNSS and three Laser Scanners – installed on a River Thames survey vessel

3D LiDAR Point Cloud – Tower Bridge



ORBIT AIM3 - User customised pull-down menus of asset types, attributes etc. simplify asset data extraction

UAV MAPPING SPECIAL

UPDATE YOUR MAPS EFFICIENTLY WITH UAVS

KEEPING DETAILED MAPS SUCH AS LAND REGISTRY MAPS UP TO DATE IS AN ONGOING WORK IN PROGRESS. THESE UPDATES ARE USUALLY PRODUCED BY SURVEYORS ON THE GROUND AND BY USING PHOTOGRAMMETRIC TECHNIQUES. THESE DAYS, THOUGH, DIGITAL LAND REGISTRY MAPS PRODUCED BY VECTORISING AND DIGITISING EXISTING MAP MATERIAL ARE AVAILABLE PRETTY MUCH EVERYWHERE.

THE BIG CHALLENGE NOW IS TO MAINTAIN THESE MAPS, WITH THE CHANGES NEEDED FOCUSING MAINLY ON SMALL, LOCAL ADJUSTMENTS.

Although conventional surveying techniques still remain in place, it is a fact that under certain circumstances it is of far greater interest to focus on UAV measurements. For a number of years now Orbit GeoSpatial Technologies have been conducting highly targeted turnkey projects involving the land surveying application of UAVs, concentrating on quality, accuracy and reliability. Using UAVs means that places that a surveyor finds hard to reach, construction sites subject to vibrations, vertical surveys for heritage restoration projects, large-volume calculations on infrastructure works, cemeteries or areas where photographic material provides clear added value and areas with where there are high buildings or bulky infrastructure no longer present an insuperable problem. Using modern UAV mapping technology, a resolution of 1 to 2 cm is easy to achieve at a cost that is definitely competitive when compared with traditional methods of collecting data.

With the assistance of the most professional UAV on the market, a usable and accurate solution can be provided for surveying and updating map material. This is a solution that goes a lot further than other 'quick and dirty' UAV techniques in which photogrammetry is not really given the opportunity to demonstrate its value on the surveying market.

THE MICRODRONE:
A UAV SUITABLE FOR ACCURATE DATA CAPTATION

Putting this device to work for mapping purposes shows some remarkable advantages compared to conventional techniques in aerial photogrammetry. A very important property of this UAV is the ease to operate and overall usability. In contrast to the use of aircraft that requires a competent and licensed pilot and the maintenance of an expensive plane, one can record very precise aerial imagery on a tight budget with a UAV. The cost to obtain aerial images is thus drastically reduced. When using this UAV, a single pilot can operate the flight as well as the taking of pictures single handed. Since the stability of the UAV is controlled automatically using a number of sensors and sophisticated firmware, and since a preprogrammed GPS flight plan can be performed fully autonomous as well as aerial imagery taken on optimized and precalculated positions, one operator can easy perform any task with minimum of efforts.

The digital aerial photographs are post-processed in a quality controlled photogrammetric workflow. The resulting products include stereo models, digital terrain models, volumes and orthophotos. Due to the employability at low altitude, the use of UAV mapping will increase the accuracy compared to what can be expected from conventional aerial photography.

The microdrone can easily be deployed in small areas where the implementation of map changes needs to be or is best based on vertical aerial photographs. Automated preparation and processing for such coverages can be performed very fast making results swiftly available for stereo viewing and softcopy mapping in e.g. Orbit Strabo. These techniques allow organizations to both update vector feature maps and high resolution and accurate orthophotos. Obviously, the resulting data is compatible with most common GIS systems.

The Microdrone UAV is autonomously powered with batteries and due to its relatively large propellers, very low in decibels: less than 68dBA at a distance of 3 metres. As a result, using the drone in a built-up area is not a source of noise nuisance. With the appropriate choice of camera and

UAV MAPPING SPECIAL

UAV MAPPING FOR THE DUTCH LAND REGISTRY: A PROFESSIONAL SOLUTION FOR 3D VISUALISATION AND MAPPING

Can a UAV (Unmanned Aerial Vehicle) compete with standard surveying techniques? This was just one of the questions that the Dutch Land Registry asked a few months ago aimed at achieving an effective and usable system for updating property boundaries in new-build districts. Orbit GT gave them a ready-made answer: a definitive outcome based on years of research and development in UAV mapping technology and software.

The assignment from the Dutch Land Registry: to survey the new-build district in Nunspeet, the Netherlands

A test area in a new-build district located the borough of Nunspeet (Netherlands) with visible boundaries (hedges, fences, walls, building, etc.) on the ground was nominated for this challenge. The aim of the test was to develop a method by which the boundaries of the individual plots could be shown on an aerial photograph and then be used officially afterwards via stereo mapping. Before the flight, the Land Registry surveyed a number of plotting and check points. The aerial photos are now being used for additional research or for placing photographic material online, providing owners with a simple, unambiguous indication of their boundaries and demonstrating whether the accuracy of stereo mapping enables the data recorded to be included subsequently as part of official surveys.

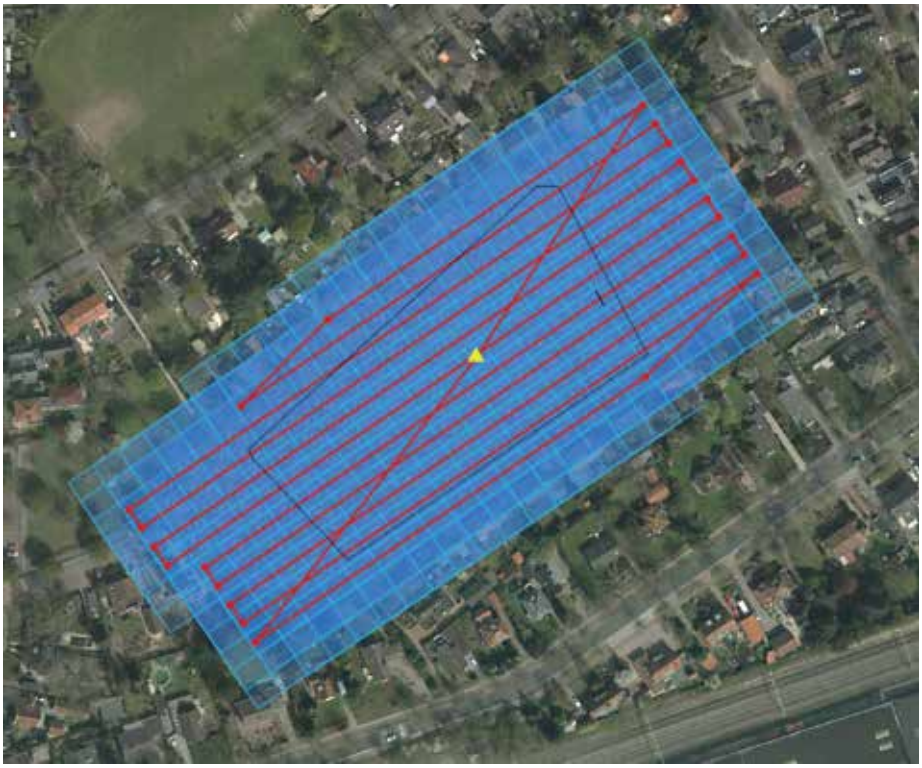
Flight planning and recording with Orbit UMP software

Using Orbit UMP (UAV Mapping Planner) software, a flight plan for the test was drafted using a minimum number of steps. The settings included (1) type of UAV (MD4-200 or MD4-1000), (2) camera mounting and specifications, (3) flight area, and (4) the parameters for achieving the best possible stereo coverage (pixel resolution, percentage strip overlap, etc.). The flight plan set out the coordinates (waypoints) for the fully automatic UAV flight and also required an accurate stereo recording. A Microdrone MD4-1000 was used. This is a UAV and is the only device that truly meets the standard requirements imposed by photogrammetry. It also enables the worldwide cooperation with the Microdrone manufacturer and dealers to incorporate a range of developments. For example, the Orbit software uses an externally developed camera mount connected to the Microdrone hardware.

After a flight lasting just 19 minutes to survey an area of approximately 1.5 hectares, the drone landed safely again. As it was a project following in the wake of two failed flights using other UAVs, this was finally a short and successful mission carried out by Orbit GT in close collaboration with the Dutch Land Registry.

Data-processing with Orbit Strabo software

After loading the images and external orientation file from the Microdrone, the project – based on a fully automatic plotting point and matching procedure – was completed in full after just a few hours of computer calculation time.



SOME SETTINGS IN ORBIT UMP

Camera: Olympus EP3

Focal: 17mm

Height above the ground:
58 metres – ground pixel size: 1.5 cm

Foto-overlap: 80/80%

Number of photos
196 – Flight time: 19.03 minutes

Photo scale:
1/3400
Average footprint per photo: 2774.1 m^2

Total land area: 1.40 hectares

The results speak for themselves: the error in x and y on object points (and ground reference points) is virtually identical to the pixel resolution (1.5cm) (z = 2x). This is certainly a level of resolution considered to be sufficient for surveying and if required can be refined further by setting a lower flight altitude or by using a different type of camera or lens.

3D visualisation and stereo mapping with Orbit Strabo

However, it is not just the speed and accuracy of the fully automatic adjustment that springs to mind, but the 3D visualisation and totally automatic DTM (Digital Terrain Model) creation make other applications achievable in practice. By adding breaklines via stereo mapping to the DTM, proper 3D visualisation and accurate true orthophotos become available, which produce some fine shots.

The accuracy of the stereo recording – based on a fixed flight plan and made using a professional UAV – means that mapping in stereo images becomes possible. As a result and

Control point coordinates (m):

POINT	X	Y	Z	dX	dY	dZ	SImsqrX	SImsqrY	SImsqrZ	SImsqr
1:	182445.465	487366.262	8.740	-0.002	0.010	0.017	0.00214	0.00218	0.00708	0.00256
2:	182411.412	487429.595	8.399	-0.003	0.001	0.008	0.00234	0.00262	0.00827	0.00299
3:	182366.192	487393.089	8.295	0.006	0.001	0.000	0.00194	0.00192	0.00590	0.00265
4:	182335.924	487365.612	8.312	0.004	-0.006	-0.007	0.00165	0.00165	0.00532	0.00233
5:	182297.672	487329.669	8.509	-0.001	0.007	0.008	0.00244	0.00207	0.00704	0.00273
6:	182350.806	487292.306	8.894	0.001	-0.012	-0.008	0.00259	0.00315	0.00902	0.00235
7:	182372.811	487314.609	8.902	-0.003	0.003	0.003	0.00221	0.00251	0.00689	0.00241
8:	182400.022	487331.990	8.755	-0.001	-0.002	-0.003	0.00210	0.00234	0.00670	0.00240
9:	182403.691	487366.978	8.627	-0.002	-0.006	-0.010	0.00201	0.00200	0.00623	0.00276
10:	182352.632	487333.035	8.568	-0.001	-0.000	-0.002	0.00148	0.00147	0.00415	0.00226

	X	Y	Z	dX	dY	dZ
MSQE:	0.000	0.000	0.000	0.003	0.006	0.008
Average MSQE:	0.000	0.000	0.000	-0.000	-0.000	0.001
Standard deviation:	0.000	0.000	0.000	0.001	0.001	0.002

Average error on ground reference points

UAV MAPPING SPECIAL

Results in 3D

using anaglyphs, stereographics or Orbit's optimized Strabox mode, 3D coordinates can be measured accurately. This enables property boundaries on the ground or any other point, line or surface element to be entered; integrating the Orbit Strabo software into the Orbit GIS package also means adding other attributes into the mix.

The next step is to use the photographs taken and the height model produced to make a fully automatic, high-resolution 'true' orthophoto. This type of orthophoto is different in that all of the 'lying down' buildings are now standing nice and upright.

In addition to supplying the proven, state-of-the-art software and technology to make all this possible, Orbit GT also take the burden off their customers by carrying out complete turnkey projects.

Pieter Jongert, Country Manager Netherlands: *"Orbit delivers an degree of accuracy that is better that the norm for surveying on the ground. These results are above the expectations of our clients. The practical implementation of this technology as part of our clients' workflows can now be seen quickly."*

Although the UAV technology presented here is not likely to replace surveyors and their theodolites any time soon, it does demonstrate that the technology can be used increasingly in specific circumstances. The photographic material produced ensures that this technology stands out clearly from traditional surveying. And it does mean that UAV surveying technology – backed by the results from this pilot project in conjunction with the Dutch Land Registry – can finally be taken seriously.

Result with stereo mapping and true orthophoto

CADASTRAL UPDATES FOR HANOI

LIKE MAY OTHER CITIES, HANOI, CAPITAL OF VIETNAM, IS FACING THE CHALLENGE TO UPDATE THEIR CADASTRAL MAP. IN PARTICULAR, IT AIMS TO EXECUTE LOCAL UPDATES, AND THE BUSTLING CITY CENTER WITH ITS HIGH-RISE DOES NOT MAKE THINGS EASIER. ORBIT GT PROVIDES THE SOLUTION.

A pilot project is put in place to evaluate whether the collection of data through UAV Mapping would be a proper solution. Orbit GT traveled to Vietnam to deliver the evidence.

The tallest buildings in the heart of Hanoi-city have a height of over 65 m. The project was flown at a height of 100 m. This results in a special challenge to the photogrammetric process: the height of the highest buildings is larger than half the altitude. In a traditional photogrammetry, objects are not higher than 15% of the height above ground level and this difference has a big impact on the photogrammetric processes.

The Orbit Strabo software however deals with this specific requirements related to UAV mapping and excellent results were delivered.

The flight planning for this project took just a few minutes, and projects that only one flight is required to cover the whole area of 7 ha with aerial photos.

The UAV was set to continuous flight: at this altitude, a stop-and-go is not required to take a crispy sharp picture and thereby to increase the overall precision. With this speed, up to 17.5 hectares per hours can be covered.

The processing of the images, using ground control points provided by the Vietamese Land Registry has resulted in stereoscopic models and a very detailed orthophoto.

The residual errors for the ground control points are: msqr x: 0.0155 m, msqr y: 0.0157 m, z msqr: 0.0396 m: a highly precise result!

The pilot project shows that one can perform data captation by means of a UAV very fast and accurate. The data captured complies with all necessities to provide a detailed mapping, and all this in a very busy urban setting including skyscrapers.

The following picture shows some yellow line markings which were mapped using stereo models captured by the UAV. This feature data is shown together with the orthophoto map coming from the same imagery and give some idea of the acquired accuracy.

The Vietnamese government has now started making updates to the cadastral map using UAV Mapping, assisted by the Orbit software packages UMP (for planning) and Strabo (for processing).

SOME SETTINGS IN ORBIT UMP:

Camera:
Olympus EP3

Focal:
17mm

Height above the ground:
100 metres – ground pixel size: 2.5 cm

Photo overlap:
80/60%

Number of photos:
139 – Flight time: 23.72 minutes

Photo scale:
1/5800 – Average photo footprint: 8080 m^2

Total land area:
6.92 hectares

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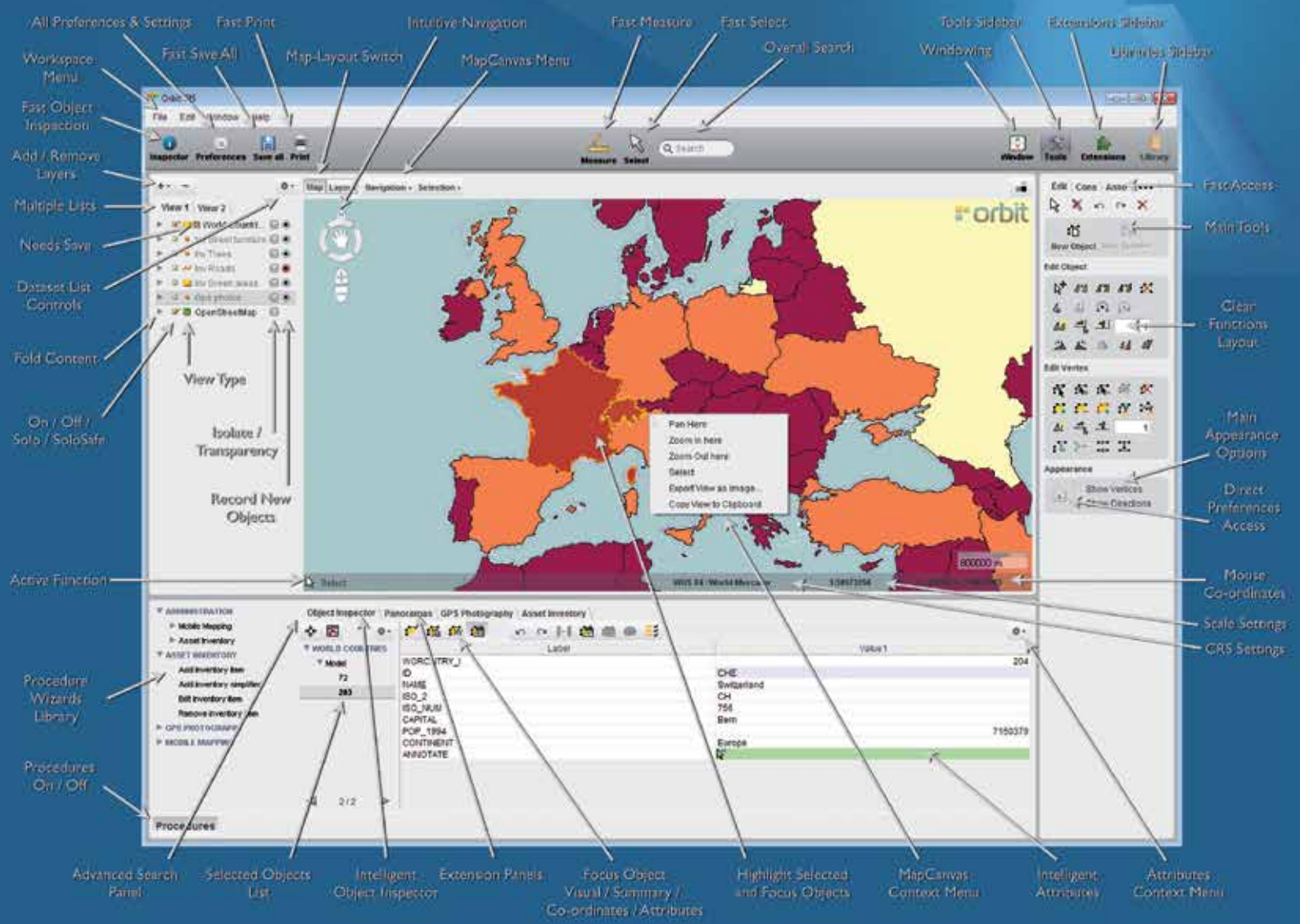
GEOSPATIAL TECHNOLOGIES

We Innovate, We Integrate.

ORBIT GIS X. Making GIS so easy.



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