

Intergeo 2014

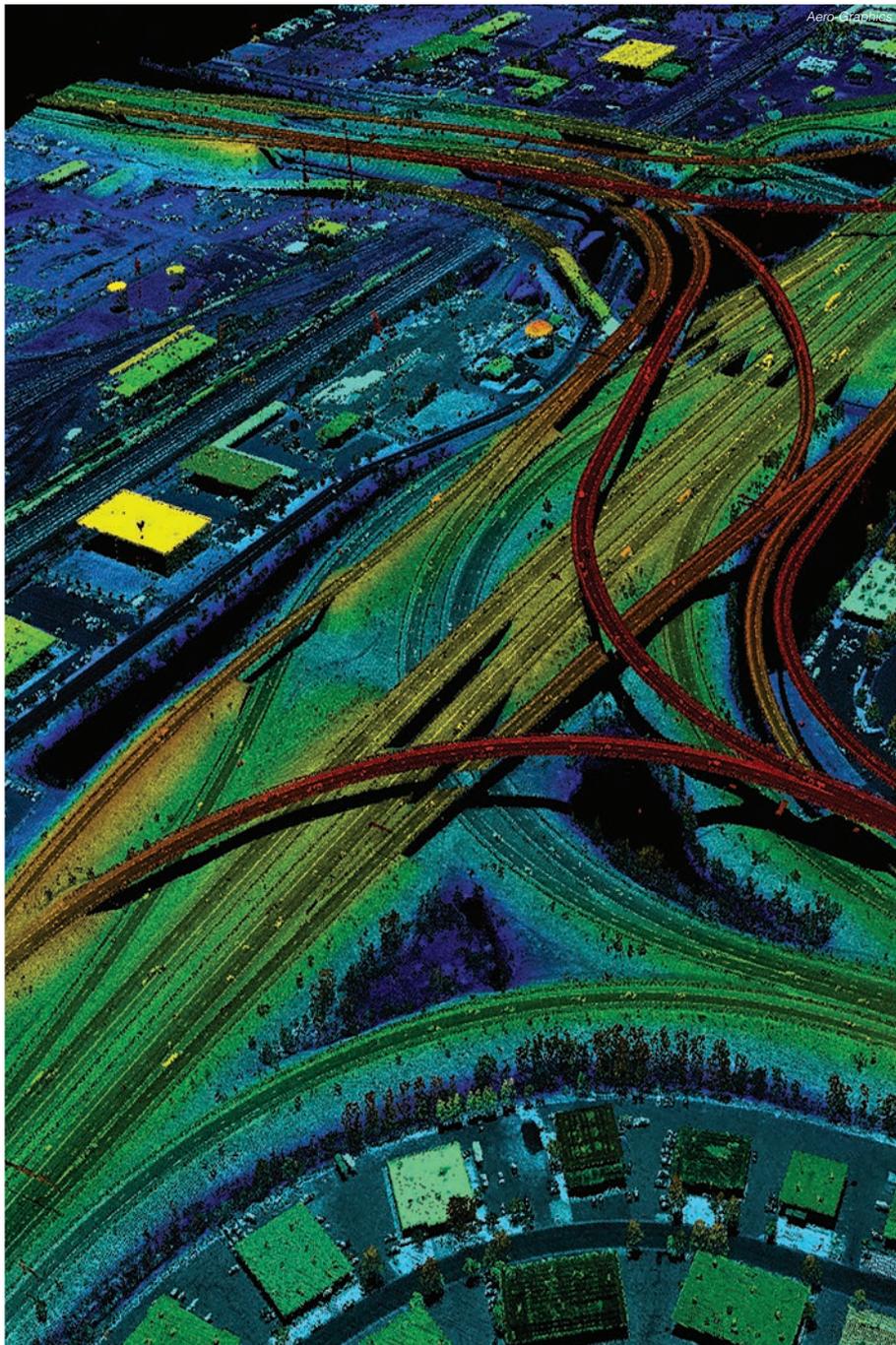
The Geomatics World Gathers in Berlin



JACK DANGERMOND GIM International Interview

POLES FROM POINT CLOUDS Automatic Extraction of Pole-like Objects

UAVs REVOLUTIONISE LAND ADMINISTRATION Fit-for-purpose Mapping



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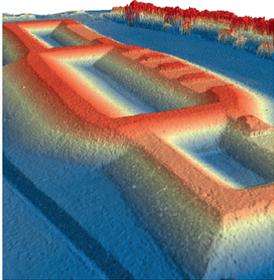
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Staying Debt-free Gives Us the Freedom to Do the Right Thing

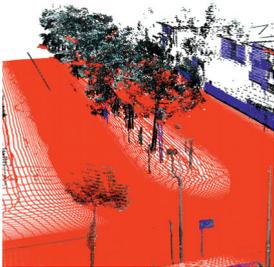
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UAVs Revolutionise Land Administration

Fit-for-purpose Mapping



The front cover of this bumper-packed October issue shows a land surveyor from Vermessung Liedtke, a Berlin-based land surveying firm. The famous *Fernsehturm*, located close to Alexanderplatz, is clearly visible in the background. Intergeo 2014 is taking place in Berlin. (PHOTO COURTESY: VERMESSUNG LIEDTKE)

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Evolution

A magazine is an evolving organism which grows and changes almost imperceptibly over the years. A 2014 edition of *GIM International* will be different from an issue dating from 2009, for example – not completely different, but alert readers will notice a subtle evolution in style and layout. Of course our designers would prefer our editors and layout department to stick to the intended design, but practicalities often win and small, practical changes are occurring all the time. This month's edition does not contain small adjustments – on the contrary! You will notice a big change: we have introduced a completely new, fresh layout suited to 2014 – and 2015 and beyond – in terms of the use of colours, fonts, illustrations, etc. While we are very proud of this new look – updated yet still recognisably *GIM International* – more importantly we are happy that we have been able to increase the amount of information we offer readers in every edition: more feature articles, more reports and more news that will be even more engaging for our loyal readers! Accompanying this brand-new *GIM International* is a product overview on terrestrial laser scanners, derived

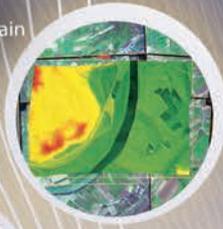
for your convenience from our product comparison website Geo-matching.com. This product overview presents specifications of 12 laser scanners from six manufacturers. I encourage you to visit www.geo-matching.com to check out plenty more laser scanners and other products. Furthermore, this edition features two articles outlining applications of terrestrial laser scanning techniques. The first is 'Surveying in the Valley of the Temples' by authors Mauro Lo Brutto and Fabio Di Salvo from University of Palermo, Italy [page 31], focusing on full-waveform terrestrial laser scanning for high-precision 3D topographic modelling of unstable rock valleys as applied by the authors' team at the archaeological site of Temple of Juno in Agrigento, Sicily. The second dedicated article is 'Deformation Analysis of a Test Dike' by Matthias Naumann and Ralf Bill from University of Rostock, Germany [page 22]. They describe the use of terrestrial laser scanning in combination with UAV-assisted photogrammetry to monitor and analyse changes in a test dike constructed of various materials in order to find the best dike material for preventing floods. But there's much more to discover in this, the thickest issue of the year. For instance, we are delighted to carry an interview with president and CEO of Esri, Jack Dangermond; read his views on the future of GIS on page 18. One more thing I would like to mention here is our preview of the 20th Intergeo [starting on page 56] that will guide you through the biggest geomatics show on Earth and help you to find new and familiar companies displaying their latest products there. This milestone event coincides with an apparent upswing in the global economy after years of downturn. Needless to say, the *GIM International* and Geo-matching.com team will be attending Intergeo in force. We are looking forward to meeting you in the German capital of Berlin, from 7-9 October, to catch up on the latest developments and discuss the brighter outlook for the future. See you there!



▲ Durk Haarsma, publishing director

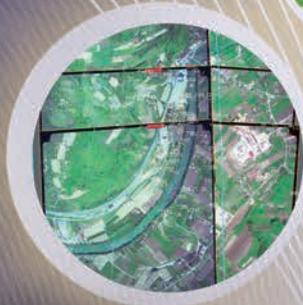
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models



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From Digitised to Digital to Diagnostic: Smart Geospatial

Over the past three decades, profiting from the amazing leaps in information and communication technology, we have witnessed significant achievements in various geospatial technology applications. These advances have created many transitional application modes, yet users have generally kept pace with rapid change. For example, travellers have migrated from paper maps to printing out online maps, to portable digital maps, to automatic navigation based on digital maps, and finally to automatic navigation with online digital maps. Many governmental applications started with digitised paper maps as the major source of geospatial information, but have now almost completely transitioned to geospatial information acquired directly in digital formats. Today, the Internet of Things is opening a new door to real-time geospatial information through various smart applications such as smart transportation, smart tourism and the smart city.

As an insider to these changes, my understanding is as follows. The digitised era is over; almost all valuable geospatial information as solidified in the traditional paper medium is now digitised. The digital era is mature and we are currently in transition from digital to



the diagnostic era – smart geospatial. All geospatial information starting from acquisition is now in digital format. Digital cameras have replaced film cameras. Total stations are digital, and data is directly streamed into a connected digital environment. Real-time observation data is now gradually being input and integrated into applications. For example, unattended hydrological stations provide continuous 24/7 observations. Surveying robots for a mine or a forest can send back multiple observation sequences unless they are remotely commanded to stop or experience unexpected failure. This real-time observation data may, under certain circumstances, trigger simple alerts, quick responses, or even prompt smart and complex decisions. The results of these subsequent actions or events provide clues to networked automated observation machines when adjusting their frequency, view angle or view field. This improves the full cycle of observation, action and diagnosis and provides improved observation results since all these steps are automatic.

Various application examples show that a new era is on the way – the smart geospatial era. This era is characterised as follows: 1) Real-time observation is the foundation for diagnosis of a geospatial situation. 2) Automation is the driving force. Observations are unattended; data streams to central databases or directly to decision systems. Thus, decisions are made automatically based on real-time data sequences. 3) Feedback is necessary for a full cycle from observations to better observations, and from good decisions to even better decisions. 4) 2D, 3D and 4D multi-resolution, multi-spectral and multi-temporal geospatial data is accumulated as part of big Earth observation data for data mining and knowledge discovery over the long term.

Let's embrace this new era! Otherwise, this new era will embrace us unexpectedly.

Deren Li, LIESMARS, Wuhan University
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Most shared during the last month from www.gim-international.com



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- <http://bit.ly/1rriX6>
2. UAV Surveys Diamond Mine in Australia
- <http://bit.ly/1uhqwEt>
3. Acute3D Brings 3D Scanning a Step Closer to the Masses
- <http://bit.ly/1rrtA08>
4. UAV Photogrammetric Mapping System Showcased in Seoul
- <http://bit.ly/1uhs7dr>
5. UAV Technology and Trends at Intergeo
- <http://bit.ly/1rrtohy>
6. Mobile Terrestrial Solution for Surveying and Indoor Mapping
- <http://bit.ly/1uhrsc7>
7. COWI Helps Border Drawing between Malawi and Mozambique
- <http://bit.ly/1IGtMT5>
8. Global Alliance to Improve Farming Through Remote Sensing
- <http://bit.ly/1uhtbOr>

SuperGIS Assists Economic Planning in South Africa

Supergeo Technologies, the GIS software and solution provider, has announced that Mangaung Metro Municipality (MMM), South Africa, is utilising SuperGIS Desktop and SuperSurv to evolve the city's economic development. The Planning and GIS Department of MMM is mainly responsible for stimulating integrated and sustainable economic development, and improving financial, tourism and human resource management with geospatial services to advance effective long-term planning.

► <http://bit.ly/1q1XBqq>

Leica Geosystems Launches Lidar Mapping Solution

Leica Geosystems has introduced its next generation of airborne Lidar solutions, the Leica ALS80. The company stated that incorporation of advanced laser technology, new high-speed point cloud generation and viewing software has enabled faster acquisition and shorter processing time along with related cost savings.

► <http://bit.ly/1AG17V6>



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The Unmanned Systems Expo to Launch in The Hague

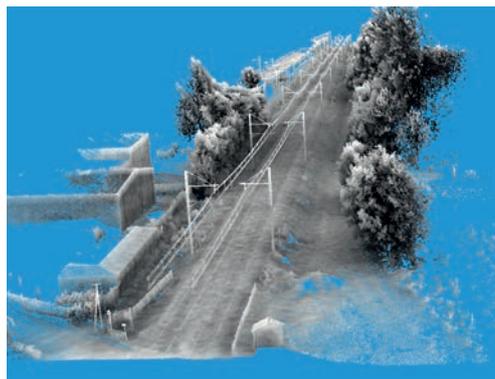
From 4 to 6 February 2015, the Dutch city of The Hague will host the first edition of the European trade show and conference, TUSEXpo. This event is aimed at the entire fast-growing market for unmanned systems such as UAVs and will feature both commercial and civil applications in areas including security, agriculture, industry, surveying, science, entertainment and environmental protection.

► <http://bit.ly/1uhqooy>

UAV Photogrammetric Mapping System Showcased in Seoul

DroneMetrex recently demonstrated its TopoDrone-100 UAV photogrammetric mapping system to international visitors at the Smart Geospatial Expo, an international event featuring the newest and most advanced trends in the global spatial information industry. The Expo was held at COEX, Seoul, South Korea, from 25-27 August 2014, and was hosted by the Korean Ministry of Land, Infrastructure and Transport.

► <http://bit.ly/1uhs7dr>



Lidar imagery of a French railway.

Lidar Mapping of French Railways for Safer Tracks

FIT ESIC, a surveying and engineering company, is helping France's national railway company SNCF to improve safety with a mobile laser scanning system from 3D Laser Mapping. Owned and operated by FIT ESIC, the rail-mounted StreetMapper was used to survey several hundreds of kilometres of track, generating engineering-grade survey data on behalf of SNCF.

► <http://bit.ly/1uhqLPO>

5 Questions to...

Chris Sheldrick



What does your company do?

The company what3words provides a human, friendly alternative to long coordinate pairs, whilst still retaining a 3m accuracy appropriate to most everyday needs. Instead of 51.611647, -0.343852 or 51° 36' 41.929" N, 0° 20' 37.867" W, you can simply use latest.laptop. pitch; all 57 trillion 3m x 3m squares in the world have been given a unique 3-word label.

How do you intend to achieve your objective of becoming an international standard for addressing?

We aim to build up a network of partners who support and use w3w alongside our growing customer base. To expand our partner network we need consumers creating demand, and partners for consumers to use their w3w with.

Your company seems to have an idealistic vision. What drives you?

What3words was spawned as a response to problems that I and others faced in the everyday communication of location. It frustrated me that there was no reference system for precise location that one could hold in short-term memory, and easily communicate by voice and other 'non-device-to-device' means – so we built a system that works well over speaking, hearing, print, text, machines and memory. What3words is an incredibly efficient communication method for long digits of numbers (lat/longs). Our biggest challenge is resistance to change from the normal substitute for lat/longs in everyday life, such as when people use common landmarks like bus shelters and lampposts. We are driven by the fact that our technology is more efficient than any alternative.

What are the main applications of the what3words technology?

Our technology can be used for most day-to-day location communication needs which require an accuracy of less than 3m. A w3w can always be supplemented with a flat number for large buildings, and street address information if the user needs more context. Just some examples include: people calling each other to commu-

nicate a location, navigation, couriers, taxis, small-business addresses, tourist guides, hotel booking correspondence, events, festivals...

Many developing countries lack an adequate address system. What role do you expect your solution to play in such countries?

We are always going to have a more dramatic effect in places where other forms of location referencing are worse. A recent Pitney Bowes report stated that less than 25% of the world has an adequate addressing system. Whilst we are not a street addressing system in that we do not provide contextual location information, we do enable a lot of services which are either hindered or impossible due to an inadequate address system by bypassing this and using the equivalent of a lat/long. Our 3-word system can also work offline for areas with poor data connectivity, meaning that real-time navigation services are enabled for anyone with a GPS-compatible device. Functionality ranges from compass-style operation for areas with little or no street data to integration with third-party offline mapping and navigation services.

► **Chris Sheldrick is director of what3words (www.what3words.com)**

UAV Surveys Diamond Mine in Australia

CADS Survey, an Australian supplier of marine, pipeline and civil surveying services, C.R.Kennedy & Co, a national importer and distributor of surveying equipment in Australia, and the German drone manufacturer Aibotix have surveyed one of the world's largest diamond mines with the Aibot X6 unmanned aerial vehicle (UAV). In doing so, they successfully executed a so-called negative waypoint flight, 100 metres below the pilot's position.

► <http://bit.ly/1uhqwEt>



Aibot X6 UAV at the Argyle diamond mine.

Satellite Imagery Company DMCii Invests in Data Centre

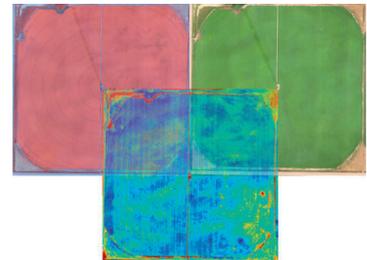
DMC International Imaging (DMCii), a global provider of satellite imagery products and services, has made major improvements to its data centre, involving a full internal upgrade of processing systems. Over five billion square kilometres of data, the equivalent of ten times the Earth's surface, is under management in DMCii's new virtualised environment.

► <http://bit.ly/1uhsWTG>

Global Alliance to Improve Farming through Remote Sensing

Tetracam and Pix4D have jointly announced a global alliance that combines the technological strengths of both companies to improve farming by means of airborne remote sensing. The alliance is the latest in a series of strategic partnerships and fast-paced product releases that typify companies producing systems for the rapidly evolving unmanned aircraft system marketplace.

► <http://bit.ly/1qIX6wF>

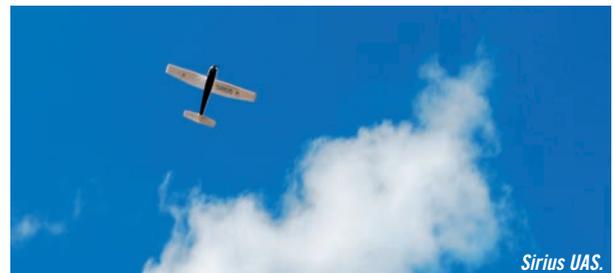


Potato pivot: IR, RGB and NDVI (courtesy: Pix4D).

Topcon Partners with MAVinci for Worldwide UAS Distribution

Topcon Positioning Group has entered into a worldwide distribution partnership agreement with unmanned aerial system (UAS) provider MAVinci. As the result of the partnership Sirius, a fixed-wing UAS series guided with Topcon GNSS positioning and powered by MAVinci technology, will be available globally.

► <http://bit.ly/1qIX6wF>



Sirius UAS.

SPAR Europe 2014 Conference Programme Launched

Technical advances, process improvements and new applications add up to an increasingly complex landscape for geospatial technologies. In view of the rapid rate of change that goes hand in hand with 3D measurement and imaging technologies, SPAR Europe brings visitors up to date on the latest insights and developments. This year's event is being held from 8-10 December in Amsterdam, The Netherlands, and is taking place alongside ELMF.

► <http://bit.ly/1AG1jnn>

3D Railway Imaging Project in Groningen

By 2020, the area surrounding the railway station in the Dutch city of Groningen must be completely revitalised. Local company Geomaat has already captured 3D images of the entire area using a 3D laser scanner. Combined with high-resolution photographic images, the company has produced a coloured 3D point cloud allowing extremely precise measurements to be performed. This makes it particularly suitable as the basis for a Building Information Model (BIM).

► <http://bit.ly/1AG3oQf>



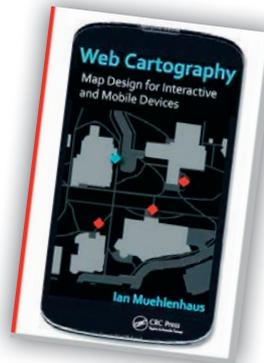
Groningen railway station.

Map Design for Handhelds

We are caught up in an unprecedented high-tech revolution. Microprocessors, solid-state mass storage devices and ultra-broadband internet allow huge volumes of data to be transmitted and received anywhere, anytime. All that is needed is a small device packed with electronics and web access. Nowadays, maps can also be sent to and displayed on handhelds. In conjunction with the advancement of positioning services, the use of maps is exploding and making them part of everyday life for billions of citizens around the world. This new mobile usage calls for a rethink of how maps look, feel and are used, especially when they are displayed on small screens. Ian Muehlenhaus, assistant professor at the University of Wisconsin, USA, recognised this need and has written a book on the subject, entitled *Web Cartography – Map Design for Interactive and Mobile Devices* (published by CRC Press). His goal is to offer students, practitioners and innovators a starting point for designing aesthetically pleasing and intuitive web maps; he promises not to bother the reader with lessons on how to write software and how to create tools. It is a practical and well-written book which offers students and web designers with no geomatics or cartography training plenty of handles for designing usable maps. The book is full of advice, including dos and don'ts and general rules of thumb. For example, it tackles the pitfall of solely striving for attractive maps and losing sight of their actual role as an information medium by stating that such maps are like "cute cat photos on Facebook: nice to look at but worthless". The illustrations are insightful too. For example, the human and canine silhouettes on page 139 clearly demonstrate that symbols should be designed to withstand both extreme reduction and enlargement. One of the premises at the heart of the book is that, in terms of concepts, designing maps to be printed on paper differs significantly from designing them for web-based used. I regard this tenet as a flaw: if it were true, why is nearly half of the book (pages 83 to 172) devoted to standard cartographic rules, including the use of colour (Ch. 5), typography (Ch. 6), Bertin's visual variables (Ch. 7), symbolisation (Ch. 8) and the creation of thematic maps (Ch. 9)? (Strangely enough, Jacques Bertin's seminal work on the Semiology of Graphics [i.e. the study of signs and symbols], which was published in French in 1967, is referred to as "Bertin & Berg, 1983, a publication of the University of Wisconsin Press", although

William J. Berg merely contributed the translation from French to English.) Of course, new media have added new cues for conveying map data: maps nowadays can appeal not only to the eyes but also to the ears and the fingertips, as shown in Chapter 11 devoted to 'Sound and Touch'. Nevertheless, while paper is indeed static and thus does not support animation (Ch. 10), animation can also be created using moving pictures or video and is not exclusively reserved for the web. At the start of Chapter 2, the author claims: "The biggest difference between designing maps for print versus the web is that we no longer design for map readers but map users," (own emphasis). However, I would counter that people also interact with and manipulate paper maps – they zoom in on details using a lens, they interact by emphasising roads with a red felt pen or encircling locations of interest, they drag distances by rolling a map odometer and tape a transparent slide on the map to redraw a portion which is useful for their goals. In short, over the course of time, the information from paper maps is transferred into unique leaflets. Added to this, maps are a means of communication, and that process involves two parties: a sender and a receiver. As far as I am aware, the way humans receive and process data has not changed profoundly over the last two centuries, except that we have become used to so many visual stimuli from movies, television, YouTube and billboards. In other words, it is not the concept that has changed but rather the flexibility, speed and ease of interaction and manipulation. As the number of users and the rate of use continue to expand and the way people use maps continues to evolve, creating good maps is becoming more essential than ever – and this requires skilled web designers who are aware of the rules and practices involved in producing them. Often, today's web designers or self-taught web 2.0 users are not familiar with those map-making rules and practices, and this accessible book fills that gap.

Web Cartography – Map Design for Interactive and Mobile Devices, Ian Muehlenhaus, published by CRC Press, Taylor & Francis Group, 262 pages, 114 (colour) illustrations, ISBN hardback 9781439876220, crcpress.com, GBP57.99



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Sentinel-1A Radar Satellite Shows Capabilities

Although it was only launched a few months ago and is still being commissioned, the new Sentinel-1A radar satellite has already shown that it can be used to generate 3D models of Earth and will be able to closely monitor land and ice surface deformation. As the first in a fleet of satellite missions for Europe's Copernicus environmental monitoring programme, Sentinel-1A carries an advanced radar instrument to image the Earth's surface through cloud and rain, regardless of whether it is day or night.

► <http://bit.ly/1uhtOmm>



Sentinel-1 radar vision.

ISPRS Symposium on Operational Remote Sensing Applications

The organising committee has announced that the ISPRS TC VIII International Symposium 'Operational Remote Sensing Applications: Opportunities, Progress and Challenges' and the Annual Conventions of ISRS and ISG plus Joint Sessions with ISPRS TC IV & VI will be held in Hyderabad, India, from 9 to 12 December.

► <http://bit.ly/1qlXkns>

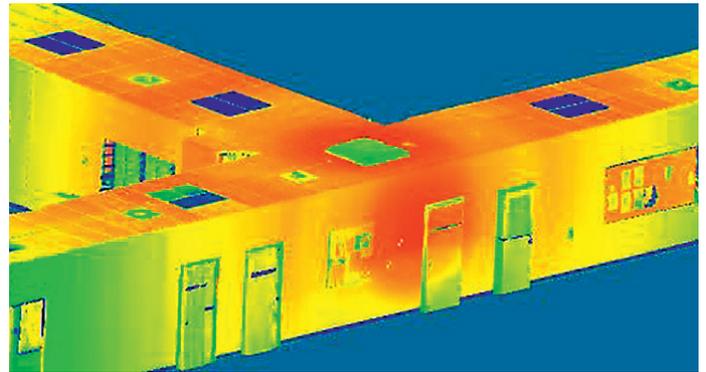
NovAtel Launches IMU-ISA-100C GNSS+INS Positioning Device

NovaTel has added the IMU-ISA-100C as an inertial measurement unit (IMU) option to its SPAN GNSS+INS line of positioning products. The IMU-ISA-100C is a near-navigation-grade IMU for platform stabilisation, general purpose navigation, photogrammetry, remote sensing and ground mobile mapping applications.

► <http://bit.ly/1qlXqvr>



IMU-ISA-100C.



3D reconstruction of a hallway.

Mobile Terrestrial Solution for Surveying and Indoor Mapping

Geomatics engineering is an emerging technology discipline that specialises in acquiring, processing, modelling, analysing and managing geospatial information. The Geomatics Engineering Department at the University of Calgary in Canada has recently developed a mobile terrestrial system that can capture dense 3D point clouds of indoor environments.

► <http://bit.ly/1uhrsc7>



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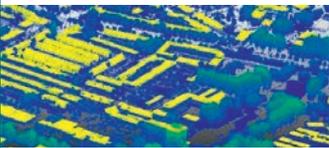
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Analysing 3D Laser Data with a Mouse Click

The Dutch high-tech company GeoSignum has presented a new method for extracting and analysing 3D laser data on geographical features and urban structures. The new web platform called GeoSignum Pointer automates the extraction and analysis of features and objects, and uses new techniques that speed up the entire data processing workflow of 3D laser scanning data.

► <http://bit.ly/1AG0v1L>



Building and rooftop extraction.

Delair-Tech Starts Partnership with Pix4D

Delair-Tech has announced a partnership with Pix4D and the release of seven new UAV system packages. Each of the new packages is targeted at different real-world usage scenarios (survey, agriculture, surveillance) and contain an entire turnkey, long-range UAV system and sensor that is topped off with training and Pix4Dmapper software for post-processing of data.

► <http://bit.ly/1AG1xuJ>

Horizon Wins Major Survey Instruments Tender

Horizon, in partnership with its Myanmar representative Zan International, has been awarded a large tender contract for GNSS RTK receivers, total stations and surveying accessories. The selection process included a series of rigorous, real-time field tests of the instruments and careful evaluation of product quality and the capability to support Horizon's range of products.

► <http://bit.ly/1qNFi68>

Publish or Perish



A sentence in the preface of the book *Web Cartography – Map Design for Interactive and Mobile Devices* written by Dr Ian Muehlenhaus (see my review on page 13) particularly caught my interest. Recognising that textbooks on the design of web maps are few and far between, Dr Muehlenhaus states: “Those that do exist tend to either be extremely technical or edited volumes that are often too academic for non-experts.” This image confirms my own observation, which I expressed in the preface to my book *Geoinformation – Technologies, Applications and the Environment*, published by Springer in 2011. I wrote: “It is becoming increasingly seldom that a textbook is written by one or a few authors... Today it is not unusual when 25 authors, or more, are involved... The topics covered are complicated and specialised.”

The crux is – why? Why are so many books published as a collection of edited conference papers? Why do so few professors have an interest in structuring existing knowledge in their field of specialisation and presenting it in a form suited to an audience of students and practitioners?

I think I know the answer: the disinterest originates in the current system of reward and career at universities. Taking a closer look at this situation, the tasks of a university are threefold: (1) creation of knowledge; (2)

conservation and structuring of knowledge; and (3) transfer of knowledge to students, practitioners and society as a whole. A naive observer would think that these tasks have the same weight and are equally rewarded, but nothing could be further from the truth. The task listed as number 1 – the creation of knowledge – has been hurled out into the far zenith (okay, I may be exaggerating slightly but it is certainly true to some extent). Nowadays it is no longer the actual creation of knowledge which matters, but rather its countable derivative: the number of articles published in high-ranked scientific journals or, to use the jargon, it is the ‘impact factor’ that counts.

I recently published several articles in this magazine and I am pretty sure that some of them will become course material. But their formal impact factor will be zero – no reward and no credits because they have been published in a professional journal instead of a scientific one. And that's not all. It is also the ability to attract funding that counts. I know of professors who have never gained a PhD, who have never published a scientific syllable, but who were appointed because of their network and thus their skills in collecting money. I know of professors who were appointed on the understanding that their education obligations would be de facto non-existent. I know of professors who are very good in knowledge transfer but whose careers have stagnated because they never gained a PhD.

When will it stop? I see signs all around the world that members of academia are getting sick and tired of the whirligig of science as a paper-production industry. I see how they are suffering as the reward-and-career system is all but bankrupt. Indeed, they are longing for release from the straitjacket of ‘publish or perish’. ◀

Staying Debt-free Gives Us the Freedom to Do the Right Thing

“Staying private and debt-free gives us a level of freedom to do the right thing that we would never have in a heavily leveraged company or public company,” Jack Dangermond states in this interview. He has been exposed to entrepreneurship from a very early age. “Success requires a sustainable revenue model, that is more money coming in than going out. This sounds simple but you would be surprised how few people understand this when starting a business.” He considers himself lucky to have discovered the world of computational geography and to have developed it into a technology that helps people apply geographic services everywhere.

What motivated you and your wife Laura to start Esri in 1969?

In the late 1960s I went to Harvard to study Landscape Architecture and was exposed to early computer mapping and

spatial analysis. I had already been doing geographic analysis manually, but at Harvard they were exploring how to do it with computers. I became interested in the application of the new data technology

developed by Carl Steinitz and others at the Harvard Lab, and began using it for several student projects and thinking about how it could be used in environmental planning and spatial decision-making. I moved back to California and started Esri, which focused on the application of that technology to real-world environmental planning projects. That led to the development of software products, and the rest is history.

Your parents, immigrants from The Netherlands, owned a family business. Esri is also a family business. Is that a coincidence?

Entrepreneurship is something I was exposed to from a very early age, so it seemed very natural to start a business that would support my interests. Today that would be called a start-up! Clearly, the business skills I learned from my parents gave me a real-world ‘business school’ education that proved invaluable.

What type of company will Esri evolve into over the next ten years?

GIS continues to grow and evolve, based on advancing technology and user



requests. Esri will also continue to grow and evolve in service to our users. Right now, we are adding cloud technology to our offerings of GIS technology. This, together with geoservices and device apps, is making GIS much easier and more pervasive, leveraging the connectivity of the web. It's embedding GIS almost everywhere, in virtually everything we do. It's our hope that this will transform how humans see the world and ultimately how they act.

Technology and societal needs are changing rapidly. What are your thoughts on how GIS tools will adapt to those changes?

Esri has a long history of carefully watching what is going on around us and adapting as an organisation. We started out as a consulting firm doing project work, and over time created a product based on what we had learned. Gradually we transformed into a software company. With recent changes in information technology and in our own offerings, we are in the midst of another evolutionary step of leveraging cloud computing and various apps that provide applied geographic knowledge pervasively. One of the things we are particularly focused on is making our technology easier to use and available to more people. This is really the 'appification' of GIS. GIS has traditionally been a professional's technology, but now we are seeing knowledge workers who have never touched GIS before accessing it through focused applications that run on mobile devices or in web browsers. Another initiative that's changing the way we and our customers operate is our increasing focus on sharing data openly. Data used to be a severely limiting factor in many applications of GIS. Now our platform comes with content. Content is not an add-on to the platform; it is integral to the platform and makes the platform come to life. This ready-to-use content is both curated by Esri as well as authored and made available by our users.

Your big data drive may be summarised as the aim to develop computational means for unravelling hidden relationships between geo-related phenomena, not only in space but also in time. How can big data play a role in unveiling such relationships?

Many of our customers are looking at ways to implement big data technology platforms. We are supporting this in a number of ways, including development of new big data tools and partnerships with big data platform companies. What people are discovering is that GIS technology is a natural platform for integrating data from many sources and analysing patterns, trends and relationships, particularly using real-time data. Maps are a way to visualise the story behind your data: seeing spatially enabled big data on a map allows you to answer difficult questions and to ask new ones that you otherwise never would have thought to ask.

Around 50% of Esri's revenues stem from US federal government agencies. There is a lot of geopolitical turmoil right now. How will the sliding panels affect Esri's business activities?

The actual amount of Esri's revenue that comes from US federal government agencies is closer to 20%. However, about 60% of our users are in the public sector, distributed at national, state and local levels and in most countries. It's not at all surprising that governments are big users of geospatial technologies. They are the regulators of

WE WANT OUR STAFF TO FOCUS ON HELPING OUR USERS RATHER THAN TRYING TO SELL SOMETHING TO GET A COMMISSION

most decisions about geography, and are responsible for managing large areas. Government users are also important creators of data. In fact, the late Dr Roger Tomlinson, the 'Father of GIS', created the first computerised geographic information system in the 1960s while working for the Canadian government, trying to get a handle on land use and resource issues across the country. While geopolitical turmoil, along with economic uncertainty, can certainly have an impact on government activities, generally speaking this turmoil has had little effect on the GIS business. Although GIS is certainly not recession-proof, there continues to be a strong interest in applying geographic information to almost every



problem. Many of these problems are exactly the kind of problems that GIS is perfectly suited to help solve.

Esri is a California-based company which is little known to the general public, in contrast to Google Maps which is used by billions of people, mostly through their smartphones. Do you have any regrets that you have never evolved into a consumer-facing company?

Google has made a huge contribution by opening the world's eyes to the power of geospatial visualisation. This has definitely

helped us and our users to explain GIS and its benefit to organisations everywhere. The geospatial market is clearly distinguished between the Google-style consumer applications and the professional enterprise market which is supporting geocentric workflows, data management, analytics and decision-making. Through the rapid growth of GIS in the cloud (ArcGIS Online) together with apps on any device, GIS has become much easier and more consumer-facing. This is exposing the full power of our users' GISs to entirely new audiences.

What is your management philosophy with respect to hiring professionals and bonus compensation? ▶

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We focus on hiring really good people who get things done. We pay them fairly, and stay focused on serving our users and developing technology that matters to them. We've always been opposed to sales-commission compensation, because we want our staff to genuinely focus on helping our users solve their problems rather than trying to sell something in order to get a commission.

What is your philosophy concerning taking outside investments stemming from stockholders or venture capital?

We have avoided outside investments and believe that has contributed to our stability and long-term success. Being independent has let us focus on what is important for our customers. Our users appreciate this. Today, we spend about 29% of our annual revenues on innovation. That's considerably more than a 'normal' public company spends annually on research & development.

What is your message to young entrepreneurs and start-ups?

Firstly, I would urge them to find something

they really like and something that really matters. Often those two things are connected. I was lucky to discover the world of computational geography and developed it into a technology that helps people apply geographic services everywhere. We made a choice from the beginning to not accept outside investment, to operate debt-free, and to stay private. I'm not saying this has been easy, but staying private and debt-free gives us a level of freedom to do the right

thing that we would never have in a heavily leveraged company or public company. Secondly, if you wish to be successful, you need a sustainable revenue model for your product or service. Simply stated, that means more money coming in than going out. Don't say "We'll figure the revenue model out later," – later might never come, or it might be too late. This sounds simple but you would be surprised how few people understand this when starting a business. ◀

JACK DANGERMOND

A landscape architect by training, Jack Dangermond founded Esri in 1969 with a vision that a mapping and analysis framework could provide a deeper understanding of our world and help us design a better future. As founder and president of Esri, Dangermond's leadership and vision stimulate the ongoing innovation of GIS technologies that enable people to make insightful decisions and improve the quality of life everywhere. Dangermond has had a strong impact on the development of GIS methodologies, the GIS software market, GIS technology research and related analytical methods. He has received many awards reflecting the influence of his work, including the British Cartographic Society Medal, the John Wesley Powell Award of the U.S. Geological Survey, the Carl Mannerfelt Gold Medal of the International Cartographic Association, the Patron's Medal of the Royal Geographical Society, and the Alexander Graham Bell Medal of the National Geographic Society.

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A TWO-YEAR MEASUREMENT PROJECT USING A UAS

Deformation Analysis of a Test Dike

Dikes play a vital role in preventing floods around the world. Typically, dikes are made of clay or marl, but these soil materials are becoming scarce in some regions. In Germany, an experimental test dike was constructed to evaluate the suitability of three other materials. Terrestrial laser scanning (TLS) and photogrammetry from an unmanned aerial system (UAS) were used to monitor the deformations of the dike. This provided valuable insights, not only into the dike deformations but also into the suitability of UAS photogrammetry for deformation monitoring.

The accuracy of deformation monitoring is determined by both the spatial and the temporal resolution of the observations. Laser scanning is a suitable method to achieve a high spatial resolution, but also comes at a high cost. Hence, it is uneconomical to apply laser scanning with a high repeat frequency. Now that UAS-based photogrammetry is becoming a mature technology, a new and affordable tool for deformation analysis is available. To test the accuracy and hence suitability of UAS photogrammetry for dike deformation monitoring, five surveys were performed over a test dike and the results were compared against a terrestrial laser scan survey conducted for reference purposes.

TEST DIKE

Dredging is necessary in many harbours and waterways around the world to maintain sufficient depth for shipping, and the dredged

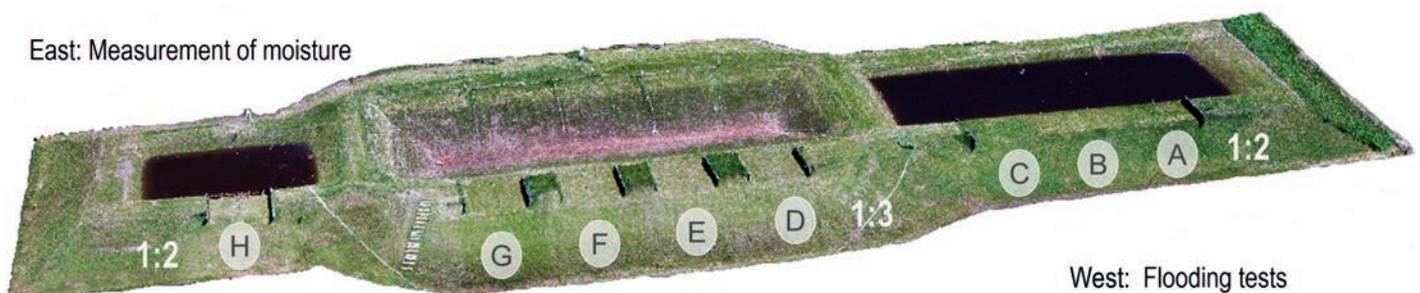
material is pumped onshore into basins where it is prepared for re-use. Until now, it has been difficult to re-use the fine-grain fractions in that material. To evaluate whether those fractions could be suitable for building dikes, a number of test dikes have been constructed within the international DredgDike project. One such large-scale experimental test dike is located in Rostock-Markgrafenheide, Germany (Figure 1). The dike has been made entirely from materials dredged from the nearby harbour and waterways.

There are two parallel dikes approximately 130m long and 3.3m high. The dikes are used to form a number of polders that can be filled with water for testing purposes. Along the dike, eight different regions are defined. These regions vary in the type of dredged material, slope and the applied geosynthetics. One side of the dike is used to test seepage

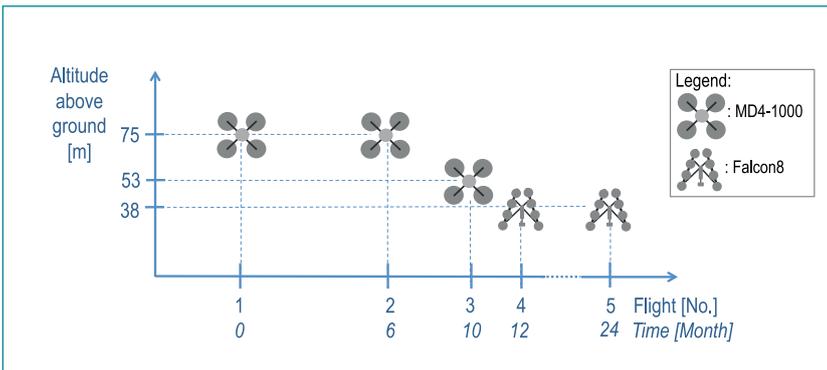
and moisture, while the other side is used for overflow experiments.

TWO MULTIROTOR PLATFORMS

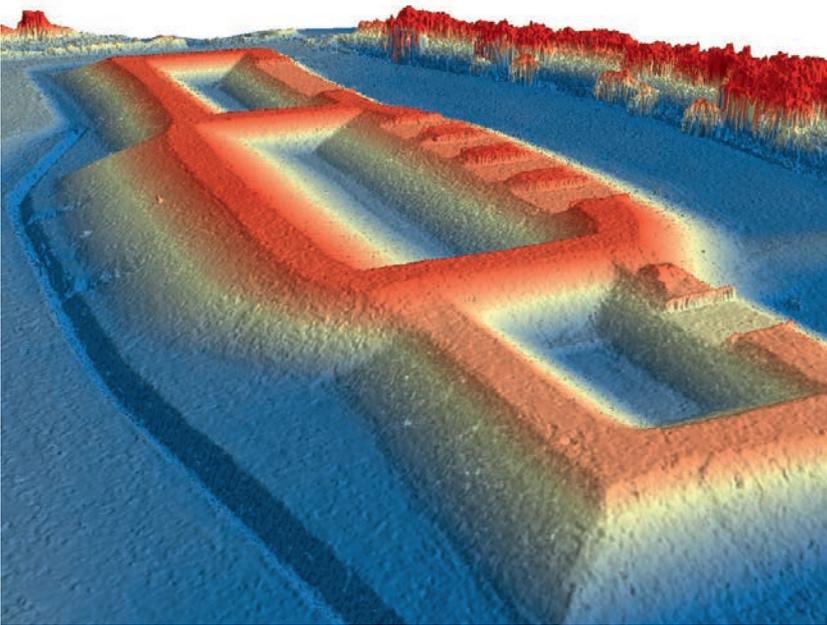
There are many micro UASs available on the market nowadays, and they often excel in either payload capacity or flight duration. The decision was taken to fly two different systems for the deformation tests in order to compare and evaluate the systems. The first three surveys were flown with the MD4-1000, a quadcopter from Microdrones GmbH with the Olympus PEN e-P2 camera using a fixed focal length of 17mm. The final two flights were conducted using the AscTec Falcon 8, an octocopter from Ascending Technologies GmbH with the Sony NEX-5 camera and a focal length of 16mm. Both UASs are standard models without further additions and integrate a GNSS, an inertial measurement unit and an active stabilising camera mount.



▲ Figure 1, Photorealistic textured DSM of the Rostock test dike.



▲ Figure 2, Duration of flights including their flying height.



▲ Figure 3, Digital surface model of the test dike.

For oblique-looking photos the Falcon 8 is predestined, which is suitable for steep areas or retaining walls. Due to its much longer flight time capability, the MD4-1000 is suitable for larger or longer dike sections.

More than 11 well-distributed ground control points were determined with accuracy of a few centimetres using GNSS-RTK. In addition, six checkpoints were surveyed with RTK and about 30 checkpoints were surveyed with a tacheometer. These checkpoints were used to cross-validate the digital surface models (DSMs) computed from the images.

FIVE SURVEY FLIGHTS

The five survey flights were conducted between June 2012 and June 2014 to measure the deformations after completion of the dike (Figure 2). The aim of the flights was to compute an accurate DSM of the dike

from the images. To do this, the software needs to find corresponding points in multiple images. These points can only be found if

FIVE SURVEY FLIGHTS WERE CONDUCTED TO MEASURE THE DEFORMATIONS OF THE DIKE

they can be clearly identified in each image, and the extremely homogeneous texture of the dike makes that particularly challenging. Therefore a very high image overlap was used, namely 80% along the flight line and 60% across the flight line, so that each point on the ground was potentially covered in at least five pictures. Doing so increased the number of observations and produced more accurate automatic aerial triangulation results. In addition, this ensured high-contrast photographs and well-distributed control points.

The first flight was flown at a height of approximately 75 metres. However, in the subsequent flight the ground surface become increasingly harder to recognise due to vegetation cover. Since a higher image resolution would increase the probability of finding ground surface points, the flying height was reduced to 53m for the third flight and 38m for the final two flights to improve the resolution.

CREATING THE DSM

All data was processed using the UAV processing software from the company Pix4D. The ground control points were measured manually in the images and the software then automatically generated the DSM (Figure 3). The spatial resolution of the DSMs was 2.5cm for the flights at 75m altitude, 1.5cm for the flight at 53m and 1.3cm for the flights at 38m.

During the first flight, the dike was simultaneously surveyed with TLS. This process took about twice as long as the UAS survey but provided very good reference data for a quality comparison against the computed DSMs. The UAS and the TLS data correlated very well with a standard deviation of 2cm after filtering the outliers. Using the tacheometric check points to reassess the quality in each subsequent flight consistently revealed a standard deviation of about 3cm.

The data from the UAS was especially good on continuous surfaces with little vegetation. However, the DSM contained large errors of up to 20cm in certain areas, such as sandy terrain with a homogeneous texture or locations with abrupt jumps in height. Poles and edges of walls were also not represented

correctly in the DSM. This error behaviour did not pose a problem for the analysis since the focus was only on large-scale terrain gradients.

DEFORMATION ANALYSIS

Using the DSM from the first flight as reference data reference data, it was compared with the DSMs from all subsequent flights by computing the differences in height for each cell using a cell size of 2.5cm. In addition to containing some large errors as mentioned above, the DSM also visibly ▶

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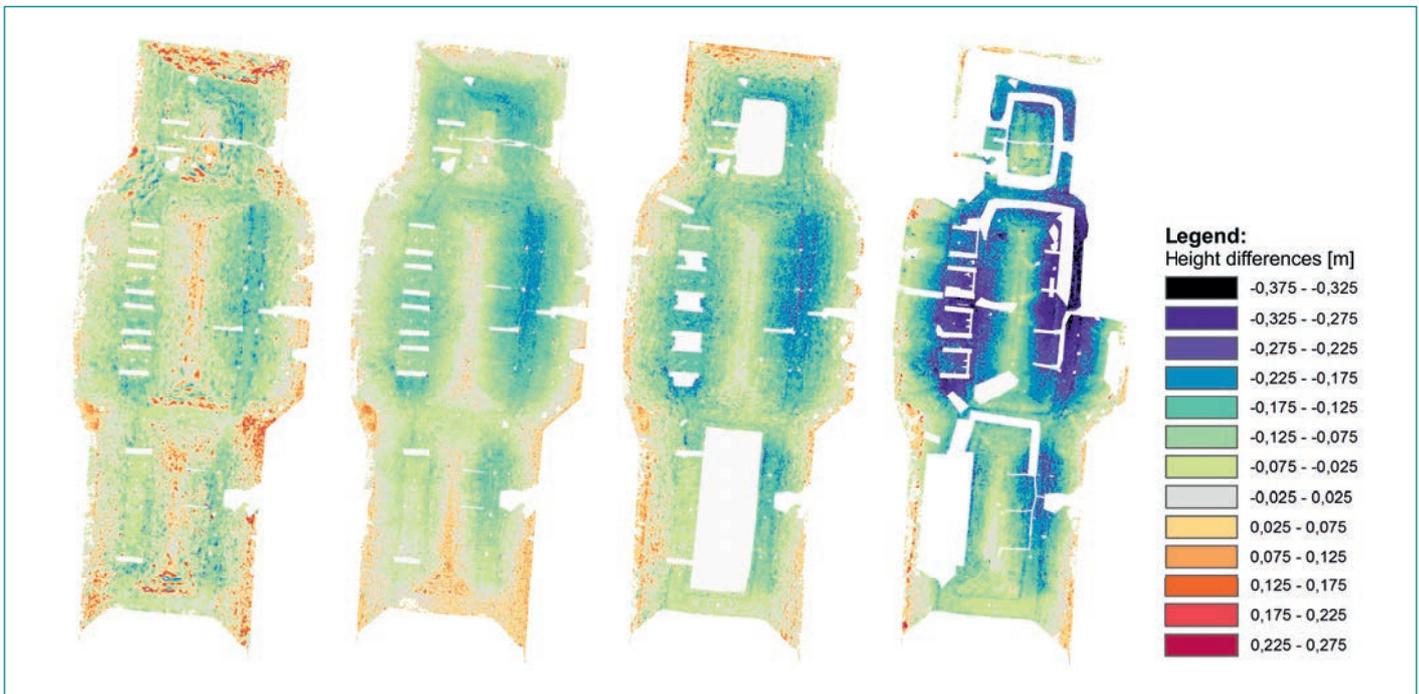
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▲ Figure 4, Differences in dike surfaces after 6, 10, 12 and 24 months.

showed people and technical equipment. Such areas were masked manually so that they would not influence the deformation analysis. During flights 3, 4 and 5 the surface was so densely covered with grass that it was no longer possible to see the ground surface in the images. Therefore the DSM computed from that data represents the height of the grass rather than the height of the terrain. However, based on the assumption that the vegetation height was constant over the entire area, it could easily be corrected by subtracting the assumed vegetation height.

AS EXPECTED, UAS MEASUREMENTS CONFIRMED THE SETTLEMENTS OF THE DIKE TO BE SEVERAL TENS OF CENTIMETRES

As expected, UAS measurements confirmed the settlements of the dike to be several tens of centimetres: after one year, the settlements were between 17.5cm and 22.5cm (Figure 4), with the rate of settlement slowing in the second year. Settlement does not occur evenly along the entire dike. There are larger differences at the eastern dike, probably because of the greater volume of that dike, while small areas with positive difference are mainly due to vegetation growth. Other small changes were also detected, such as when manmade objects were removed from the scene for instance.

CONCLUDING REMARKS

UAS photogrammetry is a very fast and cost-effective method for producing DSMs, especially when accessibility is an issue. The study found that an accuracy of approximately 4cm can be achieved on continuous terrains with sufficient texture and little vegetation. The accuracy will be lower on other terrain types. ◀

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AUTOMATIC EXTRACTION OF POLE-LIKE OBJECTS USING POINT CLOUD LIBRARY

Poles from Point Clouds

Currently, the extraction of objects from point clouds of urban sites is commonly done manually as automation is impeded by noise, clutter, occlusions and varying point density. The authors have developed a software tool for automatic detection of road signs, lampposts, utility poles, traffic lights and other pole-like objects based on the open-source Point Cloud Library. The results appear to be encouraging.

3D information about pole-like structures is used for detecting facility damage, road maintenance and other applications. Occlusion – the blocking of objects by other objects so that they are only partly visible in the point cloud – challenges the automatic detection of pole-like objects in point clouds. But even if a pole is represented by points from top to bottom, the number of points may be too small and the discrimination between poles and tree trunks or other thin-but-tall

vertical objects may be difficult. Nevertheless, a method has been developed and implemented which is based on a two-stage classification – first local, then global (Figure 1).

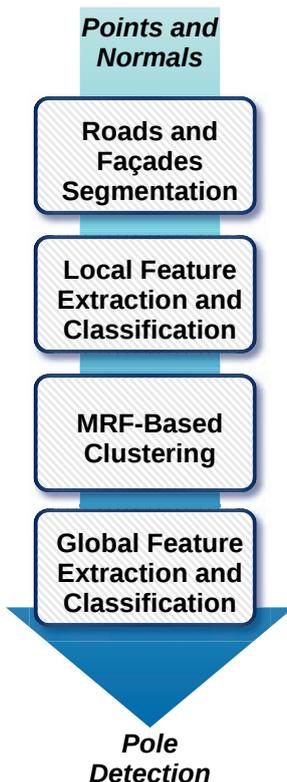
DATA REDUCTION

If the point cloud has been acquired by laser scanning, the scans partly overlap. The result is that some parts of the point cloud contain twice as many points as other parts, i.e. the point density varies. In this method, to obtain uniform point density, point reduction is applied by allowing the presence of only one point per voxel (volume element: the 3D counterpart of pixel) of a pre-specified size. When setting the size of the voxel at 1cm^3 , the distance between two points in the reduced point cloud will be 1cm or more. There will

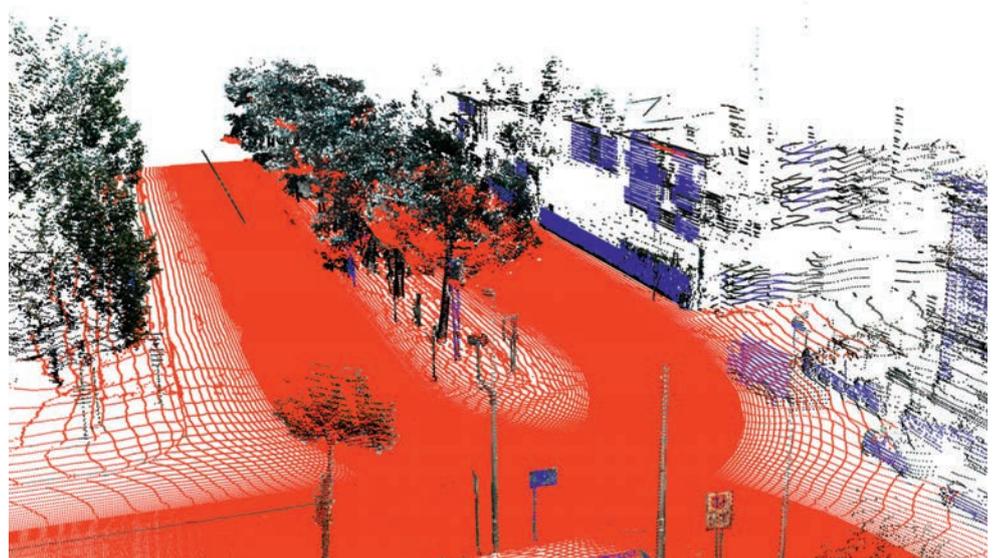
also be many empty voxels which is inefficient when dealing with big datasets since storage requirements are proportional to the number of voxels, either filled or empty. An octree data structure avoids empty voxels needing storage capacity. This was created using the open-source Point Cloud Library (PCL) (see box on page 28).

REMOVING PLANES

To reduce the number of ambiguities and to speed up further processing, roads, building facades and other planar structures need to be detected and removed from the point cloud. This was done using a new customised RANSAC (Random Sample Consensus) algorithm, which iteratively fits a pre-specified model through points robustly, even in



▲ Figure 1, Pipeline of the method.



▲ Figure 2, Two examples of removal of horizontal planes (red) and vertical planes (blue).

the presence of many outliers. The specification of the model uses the position of the points and their normal vectors, i.e. the vector perpendicular to the plane spanned up by the point itself and its nearest neighbouring points. The higher the number of neighbours, the smoother the estimation, although usually a number between 5 and 10 suffices. When the normal vectors of adjacent points are positioned in the same direction, these points most likely span up a plane (Figure 2). These points are removed to obtain a reduced point cloud used in the next steps. PCL is used to determine the normal vectors and a custom plane detection algorithm was written using PCL's Base class functionality.

LOCAL CLASSIFICATION

In a point cloud, a pole is represented as a cluster of points, which points toward the vertical direction. First, initial clusters, which may form

part of larger clusters representing poles, are detected starting from individual points and searching for points in the vicinity. The search radius depends on the diameter of the pole and may be set to between 0.2cm and 1.5cm. In this method, the focus is on the angle formed by the upward direction and the line that connects the point with each neighbour; the idea is that the distribution of such angles around a pole is highly different to that around a structure which is not pole-shaped. In the case of a pole,

to the cluster). The additional information brought in by the latter plane provides context information to discriminate real poles from similar shapes such as tree trunks. These are then re-classified with SVM, resulting in the probability that the cluster represents an actual pole-like structure.

RESULTS

Tests were conducted on a georeferenced point cloud of 1.1 billion points acquired with a Topcon IP-S2 Compact + mobile mapping

OVERALL, 75% OF THE POLES WERE CORRECTLY IDENTIFIED WITH FEWER THAN 20% FALSE POSITIVES

most neighbouring points will be either above or below, and this is reflected in the angles. For each cluster, the angles are aggregated into a histogram. Although this local feature extraction method is not part of PCL, its Feature Class was used in writing a code, relying on the PCL's input/output facilities and its radius search on a KdTree. The subsequent steps also use functionality from PCL. Based on the histogram values, each point is classified as either pole or non-pole using Support Vector Machine (SVM), a supervised classification algorithm that can learn from training samples to assign pre-defined classes to structures. The LIBSVM library is used as apparatus to carry out the classification. Training is done through providing labelled histograms of both poles and non-poles. Next, the histograms are put into SVM, which returns the likelihood that the point belongs to a pole. The high-probability point groups, which lie close to each other and together form a vertical structure, are clustered and the resulting larger clusters form the input for the global classification step.

system (MMS) in the urban area of Verona, Italy, in 2012. Because of its size, the dataset was automatically subdivided into 1,294 blocks each representing a 15m trajectory. Each block was then subsampled into voxels of 1cm³ resulting in an average of 860,000 points per block. Half of the data was used for training the SVM classifiers and cross-validation of the algorithm parameters, while the rest was used to evaluate the performance of the algorithm using manually labelled ground truth as reference. Overall, 75% of the poles were correctly identified with fewer than 20% false positives. Figure 3 shows an area with many poles correctly detected. Average overall processing time was 3.2 seconds per block. Processing time of local classification depends linearly on the number of points, and for global classification the dependency is quadratic. Hence, the subdivision into blocks helps to reduce processing time.

PCL

The method has been implemented in C++ using tools from Point Cloud Library (PCL), which is a large, open-source project for 2D/3D image and point cloud processing. It includes modules for filtering, feature estimation, recognition, registration, model fitting and segmentation. PCL emerged from the Robot Operating System (ROS) project launched by Willow Garage and is now being managed by the Open Perception Foundation, a non-profit spin-off from Willow Garage, backed up by many research institutions and companies from around the world.

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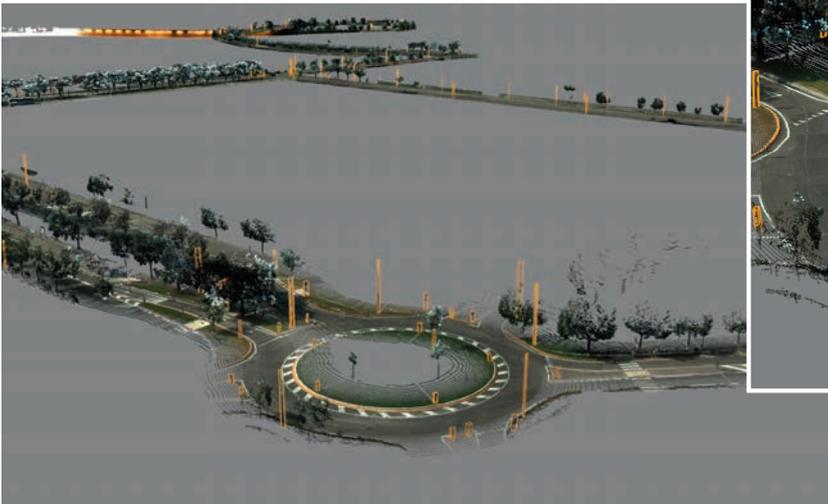
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▲ Figure 3, Bounding boxes of detected poles (orange); inset: enlargement of the roundabout. Inset: enlargement of the roundabout.

CONCLUDING REMARKS

The method has the potential to be adapted for extracting a variety of pole-like structures and can be extended for automatic detection of other objects, such as building parts, vehicles and vegetation.

ACKNOWLEDGMENTS

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USE OF FULL-WAVEFORM TLS IN 3D MODELLING OF AN UNSTABLE AREA

Surveying in the Valley of the Temples

Full-waveform terrestrial laser scanning enables high-precision 3D topographic modelling of unstable rock valleys that is valuable for various geomorphological investigations. The area below the archaeological site of Temple of Juno in Agrigento, Sicily, is characterised by the presence of large sections of rock that have fallen down from the upper ridge. In this context, full-waveform laser scanning technology was tested for the production of a highly detailed 3D topographic model at two resolutions (2cm and 20cm) for simulating potential rockfall paths at the site.

Along a long ridge outside the city of Agrigento, Sicily, is a UNESCO World Heritage Site, the Valley of the Temples, containing significant archaeological structures including the Temple of Juno (an area of about 16,000 square meters with a difference in height of about 150 meters). This area has a long history of problems related to geological instability. Being precariously close to the edge of the upper ridge (about 2-3 meters away from the temple columns), the instability is clearly deduced by the presence of medium-to-large-sized fallen blocks along the margins of the archaeological site (Figure. 1).

It facilitates the identification of the morphological features of rock structures (such as discontinuity orientations, fractures and roughness) as well as the precise size and position of rock elements, providing the

basis for the simulation of potential rockfall paths. This is critical for the monitoring of landslides and rockfalls, and leads to estimates of deformations and movements in multi-temporal sequences, supported by the sharing of data on GIS platforms.

However, TLS involves a number of application challenges such as occlusion, shaded areas, the maximum attainable resolution and surface roughness. In the digital reconstruction phase, the accurate removal of vegetation (and other noise) by point classification is also critical for generating a detailed reconstruction of slope geometry and individual blocks of rock. In this case, the ability of TLS to filter vegetation was improved by exploiting full-waveform technology when surveying a large slope

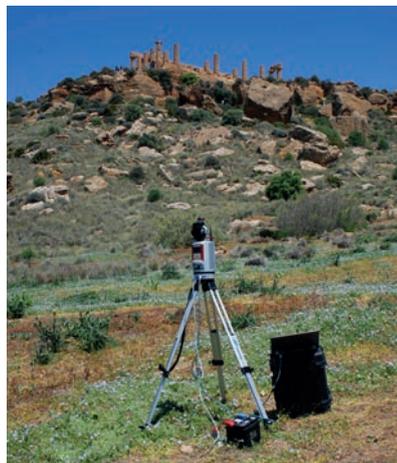
below the Temple of Juno. Such devices are able to provide multiple return echoes, allowing an automatic segmentation of points and hence facilitating more accurate 3D modelling.

TLS SURVEY

Full-waveform technology allows a pulse-detection post-processing method to be applied to the digitised backscattered signal, where a theoretically infinite number of echoes can be identified, with respect to a single emitted signal. Multi-target detection helps to separate points belonging to the soil (or continuous surfaces) from points belonging to vegetation with some limitations regarding the minimum distance between two nearby targets, usually referred as multi-target resolution (MTR). The use of full-waveform TLS offers numerous advantages, including the ability to obtain a more reliable DTM and more detailed



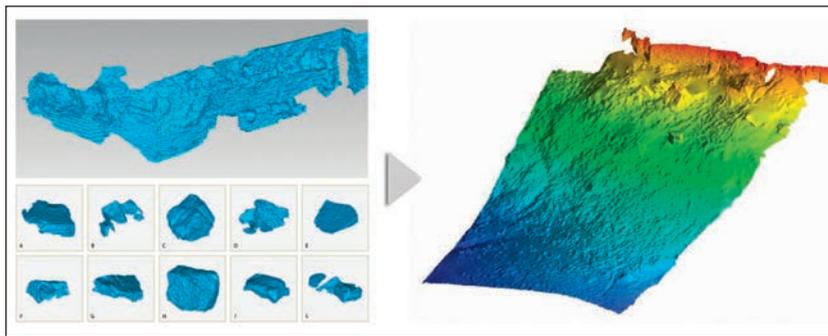
▲ Figure 1, The area below the Temple of Juno.



▲ Figure 2, Laser scanning survey.



▲ Figure 3, Laser scanner point cloud.



▲ Figure 4, Multi-resolution 3D model obtained from the relocation of all sub-models (blocks and upper ridge) on the DTM of the slope.

surfaces. The survey was carried out using a Riegl VZ-400 time-of-flight full-waveform terrestrial laser scanner (Figure 2), capable of a maximum range of 600m with a maximum resolution of 5mm at a distance of 100m. To ensure complete coverage and a detailed reconstruction of the site, 17 scans from 14 different positions were performed directly within the area so as to avoid such occlusion by larger blocks of rock, with resolutions ranging from 2cm to 10cm at a distance of 100m (Figure 3). Some targets were placed in order to align and merge all of the scans. A GNSS survey of the targets was carried out in RTK mode to georeference the final model in the UTM-ETRF2000 reference system.

FROM POINT TO OBJECT

The processing workflow was characterised by a sequence of operations with an initial phase of registration, georeferencing,

filtering and merging of each scan. A precise methodology was followed in order to obtain more morphological detail on particular elements, such as the blocks of rock and the upper ridge. During the online full-waveform analysis and point classification produced by the laser scanner, the total number of points was reduced down to about 60% (i.e. to 72 million points).

The filtered and merged dataset was sub-set by semi-automatic classification and manual selection into one group of points belonging to blocks of rock, another relative to the ridge and a third group belonging to the slope. A geometrical model decomposed into subsets was deemed to be the most useful for extracting appropriate metric information.

All subsets were individually re-sampled according to a spatial octree procedure and then triangulated: for the first two groups (rock blocks and ridge) various meshes were created with a resolution of 2cm, while for the slope a DTM with a resolution of 20cm was produced. In the final step, the comprehensive 3D model of the site was obtained through the relocation of the sub-models (blocks and upper ridge) within the DTM of the slope (Figure 4). In the resulting model it is possible to individually select various object groups to facilitate the automatic extraction of metric information (distances and volumes) and the generation of geometric elements (contour lines, vertical and horizontal sections).

During the modelling phase a number of problems were encountered relating to the exact morphological representation of the site, both in the lower part of the blocks of rock, where it was impossible to acquire useful data, and in a few areas with abundant vegetation covering the upper ridge. Further difficulties were encountered

during the editing process, which placed high demands on the processing time for certain operations.

ROCK GEOMETRY

The extraction of useful data depends on the quality of the generated model, which must by necessity have a high degree of accuracy. The reliability of geometric information also depends on the possibility to identify particular groups of points or geometric entities (such as polylines) through partial segmentation based on geometric parameters. This can usefully be adopted in CAD programs for the discrete analysis of geometric elements and their interactions (Figure 5).

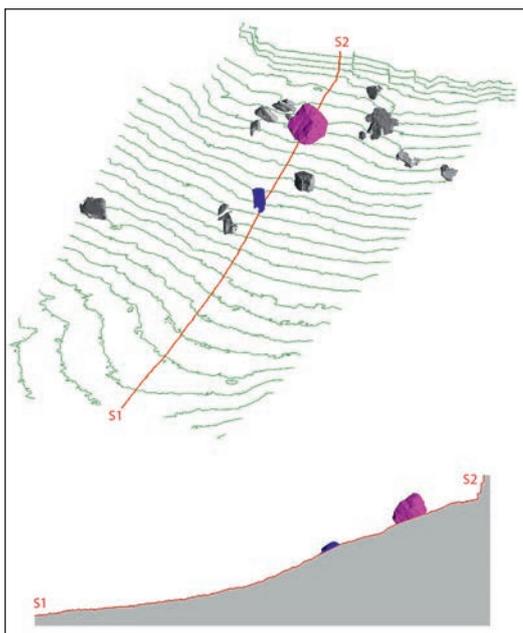
For the examined case, the detailed reconstruction of the blocks of rock enabled the determination of volume and position of each individual block with respect to the upper ridge. The individual volumes, albeit relating only to the outcropping parts, are considerable in estimating the volume of the original ridge, on the basis of an empirical law describing the behaviour of fallen and removable blocks and considering the geotechnical properties of the materials involved in the rock fragmentation process.

The overall model also serves as a base for the extraction of geometric primitives, such as contour lines and vertical sections, used to check and analyse the spatial distribution of the blocks of rock or evaluating the distances between them and the ridge. Furthermore, individual block selection allows partial analysis of the rockfall development along one predetermined direction.

POTENTIAL OF FULL-WAVEFORM TLS

The high acquisition capacity of full-waveform TLS has proven satisfactory in terms of generating a high-precision 3D topographic model in this case, and is particularly efficient where features such as vegetation, artificial and natural obstacles can limit the possibility to measure points belonging to the terrain or rock surface. While a full-waveform TLS is quite satisfactory in terms of point classification, the quality of the obtained results must be interpreted and evaluated with respect to the acquisition range, together with the laser footprint size, which depends on the angular resolution of the instrument. Indeed, for the production of valid high-resolution 3D models, a high degree of certainty in point-to-object classification is critical.

In this project, a 3D reconstruction of a



▲ Figure 5, 3D view of the slope (contour lines and main blocks of rock) and cross section through two blocks.

slope below the Temple of Juno was divided into three parts with different resolutions, according to the level of detail required for blocks, ridge and terrain. The ability to calculate the volumes of individual elements and to extract any section along different directions allowed an interpretation of rock-block detachment dynamics and an estimation of the original volume of the upper ridge. Further studies and investigations may be carried out regarding the development

of interactive models, where metric information will be directly connected to the various display scales and to the maximum resolutions associated with the individual elements. Such a multi-scale, multi-resolution approach represents a key factor that can be extensively applied to other cases.

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FIT-FOR-PURPOSE MAPPING

UAVs Revolutionise Land Administration

In 2014, a joint publication by the World Bank and the International Federation of Surveyors (FIG) entitled 'Fit-for-Purpose Land Administration' noted that 75 percent of the world's population do not have access to formal systems to register and safeguard their land rights and, therefore, there is an urgent need to build affordable and sustainable systems to identify the way land is occupied and used. The emergence of small, affordable unmanned aerial system (UAS) technology and recent advances in highly automated mapping techniques offer a new tool and methodology for producing faster and cheaper spatial data that can benefit land administration agencies and help to secure property rights for millions around the world.

A World Bank team tested the use of UAS as a way to accelerate the production of fit-for-purpose spatial data, thereby allowing local and national governments and the private sector to use the up-to-date and accurate data for multiple purposes. The tests were conducted in Albania, which was chosen due to the urgent need for new and improved cadastral maps there.

TESTING LOW-COST SOLUTIONS

With the aim to test low-cost solutions, the team used off-the-shelf components and open-source software to the largest extent possible. The following major tests were successfully conducted:

- Rural mapping applications: a rural area was chosen to test whether unmanned aerial vehicles (UAVs) could be used to quickly and reliably deliver high-resolution orthophotos for administering compensation related to expropriations for infrastructure projects. The exercise was also used to test the technology for cadastral surveying with a strong component of citizen engagement. The resulting product, an orthophoto with 2cm accuracy, provided an absolute base against which the accuracy and relevance of existing spatial information could be checked
- Urban mapping applications (see Figure 1): an urban area was chosen to test whether UAVs could be used to provide detailed maps of densely developed urban

areas with multi-storey buildings. 3D modelling using vertical photography was also tested

- Peri-urban applications: a peri-urban development was chosen to test whether UAVs could be used under production pressure in urban and peri-urban areas, and for legalisation/regularisation initiatives. Oblique photography was also added for enhanced 3D modelling.

FIT-FOR-PURPOSE LAND ADMINISTRATION

The joint World Bank-FIG publication defined the 'fit-for-purpose' approach

as one that focuses on citizens' needs rather than top-end technology. It should be flexible, attainable, reliable, inclusive, affordable, upgradeable and allow for stakeholder participation. The tests in Albania demonstrated that UAS technology is indeed fit for purpose as it includes the elements flexibility, inclusivity, participation, affordability, reliability and upgradeability.

FLEXIBILITY

Given the small form factor, low take-off weight, open source-driven flight planning, ▶



▲ Figure 1, UAS flying over an urban area.



▲ *Figure 2, Boundary demarcation based on orthophotos.*

low acquisition cost and field reparability, UASs are flexible both in terms of ease of mobilisation and the specific purpose. The vertical take-off and landing (VTOL) capacity of the specific platform chosen for the Albania context allowed for engagements in rural as well as congested urban environments. Compared to conventional aerial photography methods, UAS technology is more adaptable to weather conditions, including dark cloud cover and winds of up to 8m/s.

INCLUSIVITY

The team found that the equipment used could be employed in all types of terrain and environments, whether flat or mountainous, rural or urban. Thus, if mapping tasks are integrated with other related tasks,

this technology can enable systematic photographing and mapping of all land within a country.

PARTICIPATION

UAS technology benefits from local participation and engagement. During the tests, the team acquired images in the presence of the local inhabitants and then returned a few days later to test whether property owners would be able to demarcate their property boundaries by interpreting the orthophotos (see Figure 2). This approach of gathering and producing geospatial data promotes participation and facilitates citizen engagement in cadastral, planning and land administration activities.

AFFORDABILITY

The components making up a simple yet effective, small mapping unit can be

formerly exclusive and highly centralised task of mapping can now be relegated from national mapping agencies to local mapping enterprises able to respond to local mapping needs at short notice. Hence, governments can plan and budget for locally sourced services rather than multi-million-dollar 'one-off' projects requiring complicated and time-consuming procurement procedures.

RELIABILITY

The team found that the unit used during the work was 100% operationally reliable. The basic product of a UAV image acquisition operation consists of high-resolution (ground sampling distance between 1 and 5cm) aerial images which can optionally be georeferenced through the use of an integrated onboard GNSS receiver or by means of ground-controlled Structure from Motion map production. The contextual

THE COST-EFFICIENCY IS ENHANCED BY THE ABILITY TO 'RECORD NOW' AND 'MAP LATER, IF NECESSARY'

purchased for an amount equivalent to the price of one conventional geodetic global navigational satellite system (GNSS) rover unit (see Table 1). Affordability and relative ease of use make this technology feasible for small enterprises, implying that the

information contained in an unedited digital image is an objective record of a given situation and is, thus, not nearly as dependent on subjective interpretation as field notes collected by observers such as land surveyors. In this regard, UAV-derived high-resolution aerial photography delivers extremely reliable information that can be interpreted by all land administration professionals. Moreover, since UAVs can be called up at short notice, spatial information can be updated at much higher frequency and lower cost than would be the case with conventional wide-area updating routines currently being practised in most development scenarios. Therefore, UAV-derived aerial photography and mapping can play an instrumental role in well-managed and targeted verification and improvement of existing geospatial datasets.

UPGRADEABILITY

The cost-efficiency of this technology is further enhanced by the ability to 'record now' and 'map later, if necessary'. For example, boundary adjudication results can be recorded by means of appropriate annotation directly on photographs or mosaics rather than on finished orthophotos



▲ *Figure 3, Orthophoto with adjudicated parcels and parcel boundaries.*



▲ Figure 4, UAS launched from a rooftop in Tirana, Albania.

(see Figure 3). The decision as to whether accurate geometry is needed can be left to the future. It is important, though, that all flight planning should provide for sufficient overlap to facilitate the production of maps at a date possibly much later than the date of photography or adjudication.

THE FUTURE OF UAS IN LAND ADMINISTRATION

The tests in Albania show that UAS technology is a promising new tool for improved project design and implementation in which spatial data can be captured in a short time at a low cost (see Figure 4). Due to its rapid and easy deployment characteristics, UAS technology is most appropriate for short-notice acquisition of high-resolution digital aerial images over small areas. The technology’s highly automated and precise navigation is rapidly reducing entry barriers to mapping tasks.

The data can be used in many fields and applications, and governments, the private sector and international development partners such as the World Bank can benefit from these advances. However, as with all new technology, potential risks should be considered and managed carefully, especially since the legal and regulatory aspects lag behind. For example, data protection and data privacy, juxtaposed with the trend for broader public access to information and open data, are points that the use of UAS is bringing to the forefront of legal debates in many countries.

CONCLUDING REMARKS

Further use of UAS technology in the development-project context would benefit from general operational guidelines. Since the legal and regulatory framework for UAS operations is still evolving, and since

FURTHER READING

- Enemark, Stig; Bell, Keith; Lemmen, Christiaan and McLaren, Robin (2014) ‘Fit-For-Purpose Land Administration’, Joint FIG/World Bank Publication, FIG Publication No 60, <http://www.fig.net/pub/figpub/pub60/figpub60.htm>
- Barnes, Grenville; Volkmann, Walter; Kelm, Kathrine and Sherko, Romeo (2014) ‘Drones for peace: fast and inexpensive spatial data capture for multi-purpose use – part I of II’; World Bank Annual Land and Poverty Conference in 2014, <https://www.conftool.com/landandpoverty2014/sessions.php>
- Kelm, Kathrine; Tonchovska, Rumyana and Volkmann, Walter ‘Drones for peace: fast and inexpensive spatial data capture for multi-purpose use – part II of II’; World Bank Annual Land and Poverty Conference in 2014, <https://www.conftool.com/landandpoverty2014/sessions.php>

UASs can be purchased or assembled at a very low cost, the World Bank and other development partners should have minimum standards for safety and operations that take into account social considerations in the country context. These standards are in no way meant to be burdensome for operators, to restrict vendors or to endorse one system over another. Rather, setting minimum standards related to equipment and operational safety, field mobilisation procedures, privacy and data protection requirements, and respecting local sensitivities, will reduce the likelihood of accidents and associated liability as well as the possibility of a public relations mishap. UAS technology has the potential to become an important tool in fit-for-purpose land administration and in increasing the number of people in the world who have access to more secure and inclusive property rights. ◀

Component	Approximate Purchase Price
Small VTOL UAS	USD 3,000
Camera	USD 450
Laptop	USD 2,000
Structure from Motion software	USD 3,500
3D visualisation and virtual surveying software	USD 2,500
Total	USD 11,450

▲ Table 1, Costs of UAS components.

KATHRINE KELM



Kathrine Kelm is a senior land administration specialist at the World Bank. In 2013 she received a World Bank innovation grant to test UAVs for international development project design, implementation and monitoring.
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STUDENTS CAPTURING SPATIAL INFORMATION NEEDS

UAS Campus Survey Project

Texas A&M University-Corpus Christi, home to the largest geomatics undergraduate programme in Texas, USA, is currently undergoing a major university expansion. Both the main Island campus and the Momentum campus, which is a smaller developing campus, are undergoing extensive construction projects. The university's Conrad Blucher Institute for Surveying and Science (CBI) was tasked with devising a comprehensive way to capture the spatial information needs related to the expansion. This effort is ongoing and is being conducted by students, providing them with a unique survey experience.

The initial task was to perform a complete ground survey of all existing infrastructure at the Momentum Campus including roads, buildings, pavements and above-ground utilities. This was completed in about a semester by a group of three undergraduate students (led by author Thomas Davis) utilising a survey-grade RTK GPS and a total station. As the needs of the project grew larger, requests started coming in for aerial photos to show the new buildings evolving on both campuses. This was going to be a very costly operation because the university was requesting several aerial flights per year to monitor development. CBI came up with a more cost-effective plan by suggesting the idea of acquiring a small-scale unmanned aerial system (UAS) to meet the university's aerial mapping needs.

CBI acquired the Sensefly eBee, which is an ultra-lightweight (~0.7kg) autonomous platform specifically designed for geospatial mapping applications. This system is accompanied by its own proprietary flight control software (eMotion 2) and image processing software (Postflight Terra 3D). The current sensor payload consists of a three-band RGB camera and a three-band NIR-G-B camera, both with 16.1 megapixel resolutions. Post-processing of the imagery enables the generation of three geospatial end products: a rectified orthomosaic, a digital surface model (DSM) and 3D point cloud data.

DATA ACQUISITION

The university had to go through a lengthy and detailed authorisation process with the

United States Federal Aviation Administration (FAA) to receive a Certificate of Authorization (COA) to legally operate the UAS. In June of 2014, Texas A&M-Corpus Christi received its first COA to legally operate the Sensefly eBee over its two campuses. Because of the university's proximity to a US Naval Air Station, current UAS flight operations are restricted to Sunday mornings when air tower operations temporarily close.

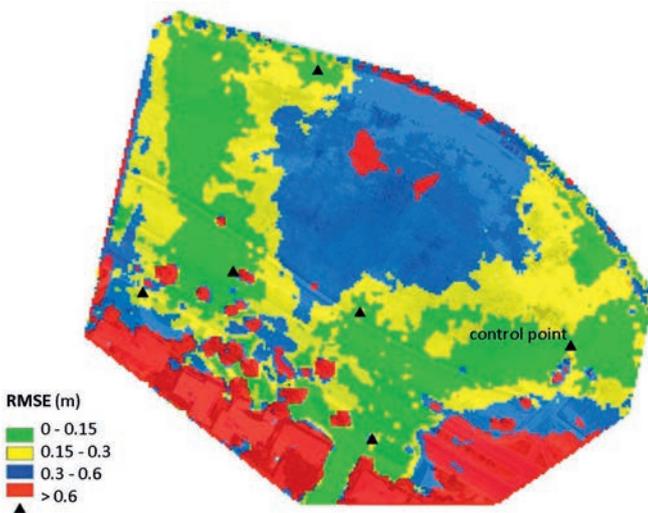
The first flight took place over the Momentum campus in early June 2014 (Figure 1). One flight at an altitude of 107 metres above ground was conducted to cover the 61-hectare campus with 60% lateral image overlap and 75% longitudinal overlap. The flying height resulted in approximately 3cm spatial resolution. The flight time was approximately 30 minutes and about 200 pictures were taken. Another series of flights was conducted a week later to survey the main campus. Two flights were flown over the Island campus to cover the ~111 hectares that encompass the main campus, utilising the same flight characteristics as the initial flight. The total flight time encompassed about 70 minutes with a total of about 350 pictures taken. All imagery was acquired with the RGB camera.

DATA PROCESSING

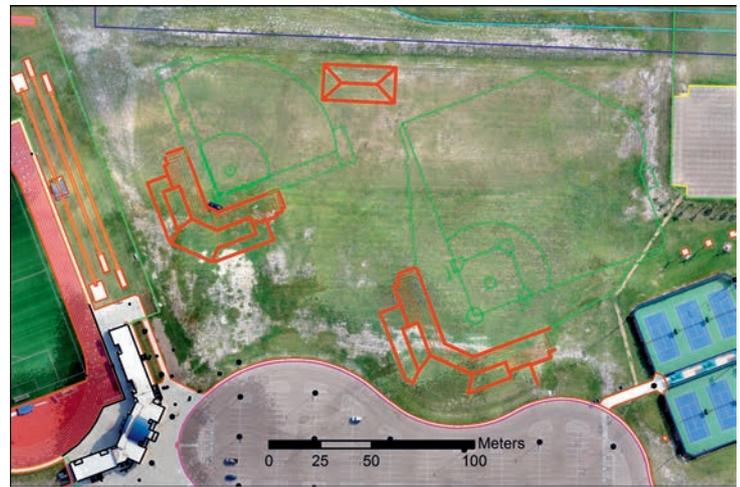
Prior to utilising the spatial data for any type of engineering, construction or planning work, the horizontal and vertical accuracies had to be examined. A small test area was



▲ Figure 1, Thomas Davis launching the eBee UAS.



▲ Figure 2, Spatial distribution of elevation RMSE between Lidar and UAS.



▲ Figure 3, Proposed plans for recreational baseball fields overlaid on UAS orthomosaic.

extracted from the flights to test the technical aspects of the UAS. The post-processing workflow consists of an initial phase of image matching and sparse point cloud generation followed by a secondary phase of point cloud densification. The densification data is then integrated to create a DSM and orthomosaic. The estimation of 3D structure from the 2D imagery in the post-processing software is performed using Structure from Motion (SfM). The software is capable of processing the raw imagery by two methods: direct georeferencing and incorporation of ground control points (GCPs).

The process of direct georeferencing is done by default in the post-processing software if no GCPs are identified. The horizontal and vertical locations are derived from the on-board GPS receiver (not differentially corrected), which is accurate to about 3 to 6 metres. The same dataset was processed again by incorporating a total of six GCPs spread throughout the entirety of the sample data set. The GCPs were collected on the ground by using a survey-grade differential GPS that was tied to a Virtual Reference Network (VRS), which is accurate to about 2.5cm horizontally and 5.0cm vertically.

HORIZONTAL ASSESSMENT

The horizontal accuracy assessment was performed by comparing the distance on the image to the distance on the ground for independent control points measured in situ using a survey-grade GPS receiver.

With the direct georeferencing method, the independent checkpoints were an average of about 6 metres off; however, it is important to mention that the relative baseline distance between points exhibited sub-metre accuracy. In comparison, the integration of high-accuracy ground control into the processing workflow resulted in an average planimetric offset between the imaged derived checkpoint and control points of about 0.08 metres. This is a significant increase in the horizontal accuracy of the UAS-derived products, and demonstrates that the UAS is capable of producing survey-grade planimetric mapping results. Additionally, at up to 29 km/h, wind conditions were relatively high on the morning of the flights. The results further demonstrate the potential of the system to acquire accurate data during less than optimal conditions.

VERTICAL ASSESSMENT

The vertical accuracy of the topographic data derived from the UAS was compared to an airborne Lidar survey acquired over the same area in 2011. Differences in elevation were computed by deriving a DSM from each method at 0.5m resolution and performing a raster difference (Lidar DSM – UAS DSM). Figure 2 shows the spatial distribution of elevation RMSE computed from the difference raster using a 3 x 3 moving window. The raster shows an apparent pattern of RMSE increasing as the distance from the control points increases. Since

there is an approximate three-year separation between the surveys, cars parked in different places and other landscape changes can explain some of the high outliers observed in Figure 3.

Overall, the average difference in elevation between the two methods over the study area was approximately 0.13 metres. The positive elevation bias indicates that the elevations derived from the Lidar were slightly higher relative to the UAS. Observed elevation differences can stem from a variety of factors including differences in the 3D measurement methodology (e.g. Lidar DSM derived from first-return points compared with UAS DSM derived from imagery via SfM), point sampling density, natural modifications of the land surface during the span of the survey, vegetation changes, and others. Finally, it is important to mention that the vertical comparison presented here is only relative between the two methods for the given survey conditions. No assumptions on absolute accuracy should be made because the results were not based on an

YOUNG GEO IN FOCUS

‘Young Geo in Focus’, published bimonthly, offers recent graduates or postdocs the opportunity to share their experiences with our worldwide audience. If you’ve just completed an innovative project with your first employer or finalised your PhD research with results that are of interest to practitioners feel free to contact the editorial manager at wim.van.wegen@geomares.nl.

Pythagoras is a state-of-the-art CAD and GIS software for land management, road design, civil engineering and land surveying. It is one of the most powerful and intuitive CAD and GIS applications ever designed. Powerful tools allow users to quickly design projects in a user-friendly way.



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Pythagoras **Geocoding**

Pythagoras Geocoding lets you generate your drawing in the field. The use of codes transforms field data into symbols and lines without having to draw one object.



Pythagoras **Road Design**

Pythagoras proves to be a powerful, yet user-friendly application for road design. Well designed windows will show you the field data and an adjusted control panel will help you design the horizontal and vertical alignment.



Pythagoras **GIS**

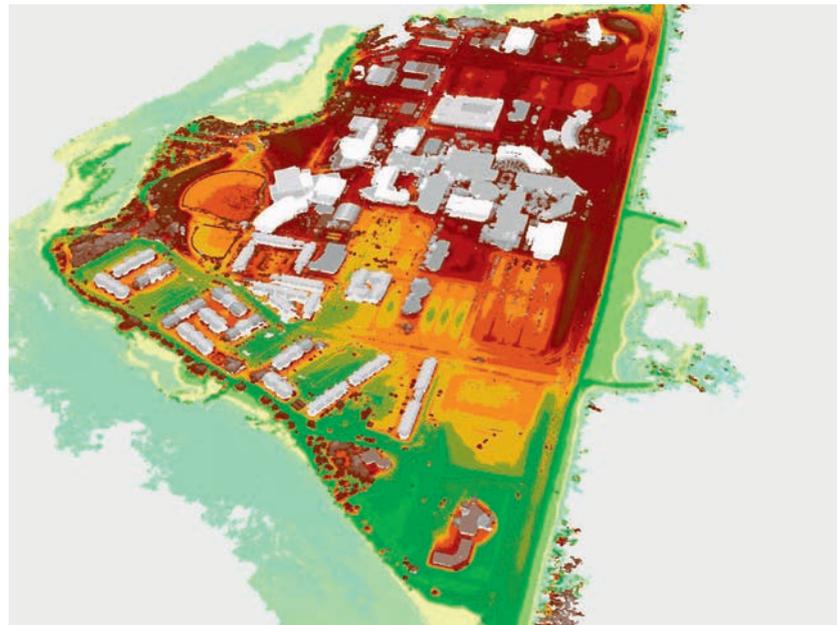
Pythagoras offers a GIS module that allows users to create GIS maps and perform analysis on these GIS projects. Creating and filling up databases, which can be linked to any objects, make it all possible.



independent set of higher-order vertical control (current study underway).

UAS IMPACT ON DECISION-MAKING

After the accuracies were verified, the products derived from the unmanned flights were incorporated into the projects assigned to the Conrad Blucher Institute. One immediate impact of the integration of the unmanned technology was the ability for the university to plan infrastructure projects using the orthomosaic as a high-accuracy base layer within a unified coordinate system. Prior to the ground surveys and orthorectified aerial imagery, the planners had to use arbitrary coordinate systems with rubber-sheeted imagery that was several years old. This would often cause problems because engineers and architects did not know how much area they had to plan with or did not have a real-world view of the topography surrounding their work projects. Figure 3 shows how the existing survey data and the UAS imagery can be utilised to help planners fit their designs for a proposed baseball field on the Momentum campus. The new system allows for planning with continually updated survey data and



▲ Figure 4, 3D point cloud of the Island campus, colour-coded by elevation (lighter = higher).

The 3D point cloud data derived from the UAS has also proven to be a very useful tool for the university (Figure 4). It allows for planners to estimate the heights of

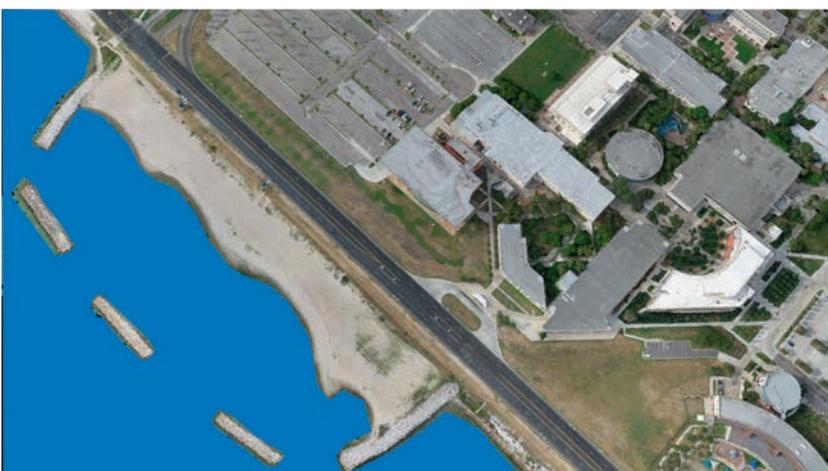
Christi Bay, and the topographic data derived from the UAS is being applied to monitor beach erosion and guide management efforts (Figure 5).

THE 3D POINT CLOUD DATA DERIVED FROM THE UAS HAS ALSO PROVEN TO BE A VERY USEFUL TOOL FOR THE UNIVERSITY

imagery, and helps speed up the process from design to construction of infrastructure projects. The imagery is also being used by campus police to serve their GIS information needs.

features on the campus as well as derive 3D building models to provide new visualisation perspectives. Furthermore, the university has an engineered beach located along Corpus

Today, a new team of students are leading the charge on the campus survey project. All UAS-acquired data is processed and analysed by the student survey team and fed directly into the campus decision-making process. The end result is a dynamic learning environment that exposes Texas A&M-Corpus Christi geomatics students to the frontiers of UAS surveying and empowers them with the opportunity to have their efforts directly help guide and shape the future growth of the university. ◀



▲ Figure 5. 3D point cloud textured by the RGB imagery showing the university beach.



Thomas Davis

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Dr Michael Starek

Dr Michael Starek is an assistant professor with the GISc and Geospatial Surveying programme at Texas A&M University-Corpus Christi, USA, and serves as advisor to students for the campus surveying project. ✉ michael.starek@tamucc.edu

REPORT ON THE FOURTH SESSION OF THE UN-GGIM

Importance of UN-GGIM Initiative Continues to Grow

The Fourth Session of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) was held from 6-8 August 2014 at the United Nations Headquarters in New York City, USA. UN-GGIM is continuing to move forward towards enhancing collaboration between Member States and assisting in making accurate, reliable and authoritative geospatial information readily available in support of national, regional and global development.



▲ *Stefan Schweinfest, newly appointed secretariat of the UN-GGIM, flanked by the co-chair.*

Ministers and senior leaders from United Nations Member States and international organisations and societies including ISPRS, ICA, FIG, IAG, Worldbank and FAO and many more spent three days discussing mapping and location issues affecting the world. In his opening speech of the session, Mr Wu Hongbo, United Nations Under-Secretary-General for Economic and Social Affairs, said: “It has only been three years since the Committee of Experts started its worthy journey that has already resulted in a number of early achievements. The level of Member State participation has increased, as evidenced by the attendance figures over the past two sessions. The number of work areas has grown where expert and working groups have been created; and your work has really drawn much wider attention and support from the international community.”

AMBASSADORIAL ROLE

During the Fourth Session, UN-GGIM moved forward towards fulfilling its important mandate to enhance collaboration between Member States and to assist in making accurate, reliable and authoritative geospatial information readily available to support national, regional and global development and the important sustainable development agenda. What Hongbo pointed out in his opening speech was exactly what became clear in the days that followed. UN-GGIM furthered the extent to which it is embedded in the governmental and policymaking environments of the United Nations Member States. The ambassadorial role of the United Nations for the use of geoinformation is not to be underestimated and will have a positive effect on geomatics as a whole.

STRATEGIC

The Committee of Experts successfully dealt with strategic issues such as: the enhancement of the global geodetic reference frame; the identification of approaches for legal and policy frameworks, including privacy laws required to support the use of authoritative geospatial data; the development of global mapping for sustainable development; the establishment and implementation of geospatial standards; the linkage of geospatial

information to statistics; and the definition of a shared statement of principles for the global geospatial community. The use of authoritative geospatial information is beginning to change the way in which global challenges such as climate change, disease pandemics, food shortages, economic crises and disaster recovery situations are predicted, monitored and managed. One example is where authoritative geospatial data is used by emergency services in rapidly changing environments, such as landslides, floods and earthquakes, enabling them to gain situational awareness of the disaster areas faster and hence to save more lives. Throughout the event, capacity development of countries – through training, advisory services and encouraging good governance of geospatial information management – was keenly supported.

GLOBAL GEODETIC REFERENCE FRAMEWORK

During the Fourth Session, the Committee of Experts also debated and endorsed a draft resolution on a Global Geodetic Reference Framework (GGRF) for Sustainable Development for further referral to the General Assembly. There is a growing requirement for more accurate measuring of the changing planet down to millimetre level, since geospatial data impacts on countries' economies as well as their environments

and hence leads to economic benefits. Therefore, UN-GGIM recognises the need for global co-operation and contribution to the GGRF under the overarching umbrella of the United Nations. The Committee of Experts is considering how to enhance intergovernmental co-operation, which will lead to geospatial data interoperability.

REGIONAL INITIATIVES

Several regional UN-GGIM initiatives shared their progress, working plans and agendas during the Session, including the UN-GGIM Americas, the UN-GGIM Middle East and UN-GGIM Asia Pacific, all of which are already well established. Delegates were updated on the plans for setting up regional UN-GGIM groups in Europe and Africa. The regional initiatives are becoming more and more institutionalised and therefore are increasingly growing in importance in their own region to share, extend and implement the message of the global Committee of Experts.

APPEAL

At a reception held by the United Kingdom ambassador to the United Nations, an appeal was made to the delegates to return to their respective countries and act as ambassadors for the right use of geoinformation for the betterment of the environment and, together with that, sustainable positive effects on the world's economies. Vanessa Lawrence, co-chair of UN-GGIM, reiterated that appeal when she closed the session, mentioning again the importance of being an ambassador: "Geodata is so vital in monitoring, and accurate geodata serves as basis of so many other fields, that you should convince your political masters to acknowledge this, leading up to a positive decision on the permanent establishment of UN-GGIM by ECOSOC in 2016." By the time the Session closed, the progress made during the three-day meeting in New York City had made it very clear that delegates were taking that message seriously. ◀



▲ Co-chair Vanessa Lawrence addresses the floor.

MORE INFORMATION

For information on the Fourth Session, including the agenda and technical reports, please visit: http://gim.un.org/ggim_committee.html. The Fourth Session of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) was streamed live and is now available on demand on the United Nations Web TV website at: <http://webtv.un.org>.



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TI ASAHI

Serving the Surveying World

Japanese company TI Asahi has been supplying surveying equipment to the industry for more than 80 years. It has an ongoing commitment to developing high-quality PENTAX and Linertec products which improve the efficiency and ease of surveying operations around the world.

The head office of TI Asahi is located in Saitama-shi, Saitama-ken, Japan. Its main functions are Research & Development, Production, and Sales & Marketing. The company supplies PENTAX surveying instruments, which are mass produced at its factory TI Precision Shanghai in Shanghai, China, to over 80 countries around the world through a network of experienced sales and service partners.

2013 marked the 80th anniversary of the launch of the PENTAX surveying business. The company originated in 1933 when Fuji Sokuryo Manufacturing was established. That company developed and supplied not only levels, transits and optical theodolites but also special products such as tilting levels with cameras, jig transits, axis-alignment transits and pantographs, under the brand names of Fuji and Geotec.

The company was merged into the PENTAX group in 1967. From then on, the incorporation of advanced optical and

electronic technologies resulted in successful market introductions including electronic distance-measuring instruments, electronic theodolites and total stations which were all sold under the PENTAX brand name. In 2009, the business was transferred to TI Asahi, which was at that time a newly established company in Japan, as a subsidiary of TIC Group, for the purpose of continuing and further developing the PENTAX surveying instrument business.

PRODUCTION CAPACITY

The main factory of PENTAX surveying instruments, TI Precision Shanghai, was founded in 2003 as a joint venture between TIC Group and Pentax Corporation. It has been 100% owned by TIC Group since 2009. In 2011, TI Precision Shanghai built a new factory in the Song Jiang district of Shanghai in order to increase production capacity. Today, most products are shipped from Shanghai to customers around the world, although some products are manufactured in Japan in order to meet

At Intergeo 2014 in Berlin, TI Asahi will introduce a number of new products such as a PENTAX Windows CE total station, a reflectorless total station, a digital level and a GNSS receiver. The company is located at Stand no. C4.008.

special requirements – such as those which are required to display 'Made in Japan' as the country of origin. Both TI Asahi and TI Precision Shanghai are ISO9001 certified, and all products are manufactured within the framework of a very strict ISO9001 quality management system.

PRODUCT RANGE

The range of PENTAX surveying instruments consists of total stations ranging from high-end to entry-level, electronic theodolites, automatic levels, laser instruments, GNSS positioning systems, 2D/3D scanning systems, hand-held instruments, various types of survey software, peripheral instruments and accessories. PENTAX surveying instruments are characterised by highly advanced and unique technologies such as autofocus and automatic atmospheric correction functions. These technologies are not only unique but, through functional matching with software, also contribute to the ease of operation of the instruments and greater surveying efficiency in the field.

In addition to its PENTAX products, TI Asahi launched a new product line under the Linertec brand name in 2013. The Linertec range of surveying instruments also



▲ TI Asahi headquarters in Saitama, Japan.



▲ TI Precision Shanghai premises.



▲ Linertec LTS-202N total station.

includes total stations, electronic theodolites, automatic levels and GNSS receivers positioned at more affordable prices in order to offer a competitive alternative in the market. PENTAX is already recognised by global users as one of the top brands

of surveying instruments, and the new Linertec brand is expected to follow suit. Due to the relatively recent brand launch, sales channels of Linertec products are being strategically developed in different regions. However, the company intends to expand its sales channels at a fast pace, and is currently looking for new and valued partners all over the world. New products will continually be added to the Linertec product family in order to



▲ PENTAX range of products.

fulfil customers' demands, which the company expects to become increasingly diversified as the technological and commercial needs within the surveying and construction industries continue to evolve rapidly.

GIS-BASED SOCIETY

TI Asahi is committed to developing PENTAX and Linertec products that can contribute to a GIS-based society by improving the efficiency of surveying and ease of operation in the field. The company intends to keep supplying its products to industry customers right around the globe through its sales and service network of highly experienced partners. ◀

Every month *GIM International* invites a company to introduce itself in these pages. The resulting article, entitled Company's View, is subject to the usual copy editing procedures, but the publisher takes no responsibility for the content and the views expressed are not necessarily those of the magazine.

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“... AND THE
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Officially announced on 11th August 2014, HORIZON, partnering with our Myanmar representative Zan International, has been declared the winning bidder and would be awarded the contract for possibly the world's largest tender called for GNSS RTK receivers, total stations and surveying accessories. This was after a series of rigorous, real-time field testing of the our instruments, and a careful evaluation of our product quality, company and brand history, and our capability to support the products we offer. We would be supplying 520 units of Kronos 200M GNSS RTK receivers, 520 units of controllers, and 100 units of HTS-582M total stations along and a large number of accompanying survey accessories after being awarded the tender.

The tender was called by the Settlement and Land Records Department (SLRD), a part of the Ministry of Agriculture and Irrigation of Myanmar in early 2014.

We would like to take this opportunity to thank SLRD for the opportunity given for us to work with them, to the support and cooperation rendered by our representative company in Myanmar Zan International, and to our global partners, clients and associates who have given us the steadfast vote of confidence, faith and goodwill all these years.



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Call for Papers for FIG Working Week, May 2015, Bulgaria

The next FIG Working Week will be held in Sofia, Bulgaria, from 17-21 May 2015. It will be jointly organised by FIG and the Chamber of Graduated Surveyors of Bulgaria and will be supported by all relevant local major sectors. The FIG Working Week gathers together international practitioners and academics from all disciplines within the surveying, geospatial, natural and built-environment professions (land surveying, land administration and management, land and property appraisals, spatial sciences, spatial planning and development, positioning and measurement, engineering surveying,

2015 FIG FOUNDATION PHD SCHOLARSHIPS AND ACADEMIC RESEARCH GRANTS

The FIG Foundation is an independent body under the International Federation of Surveyors. The Foundation has been established for the purpose of raising funds to finance educational and capacity-building projects and scholarships. The FIG Foundation will be providing scholarships of up to EUR4,000 to PhD students. Deadline for application is 1 February 2015. Furthermore, the FIG Foundation has announced a research grant of up to EUR30,000 spread over three years. Deadline for application is 31 March 2015.

Conditions, requirements and further information are available at:
www.fig.net/figfoundation.



▲ Banner of the 2015 FIG Working Week.

hydrography, environmental and green building, and cost, construction and project management). The FIG Working Week 2015 will furthermore reveal the work plans for the new FIG Council as well as all 10 FIG Commissions for the term 2015-2018. The selected theme of the conference is 'From the wisdom of ages to the challenges of modern world'.

The carefully prepared Technical Programme will offer specially invited high-profile presentations as well as papers that are selected through the open Call for Papers procedure. The Call for Papers is open for both peer review and non-peer review submissions.

NON-PEER REVIEW – SUBMISSION OF ABSTRACTS

Abstracts may be submitted for either 'full' or 'short' oral presentations. A full presentation is a 10- to 15-minute presentation whereas a 'short' presentation lasts for five minutes. Please note: the deadline for the online submission of abstracts is 15 November 2014, and the deadline for full paper submissions is 1 March 2015.

PEER REVIEW – SUBMISSION OF FULL PAPERS

To submit a paper for the FIG peer review process, full papers must be received by

20 October 2014. Papers may be submitted on any topic related to the specific topics of FIG 2015. Each paper will be reviewed by two independent reviewers and, if the final paper passes the peer review process, it will be presented at the Working Week as a 'peer reviewed paper'.

All abstracts and papers must be submitted in English. Authors of papers that are accepted for oral presentation must register for the conference before 15 February to be included in the programme.

We encourage all professionals who have an interest in surveying to participate actively as we are sure that this Working Week will prove to be highly successful and rewarding for everyone involved. ◀

Chryssy A Potsiou, Greece, FIG president elect
Zlatan Zlatanov, co-conference director
Louise Friis-Hansen, co-conference director/
FIG manager

More information

Conference website and abstract submission: www.fig.net/fig2015



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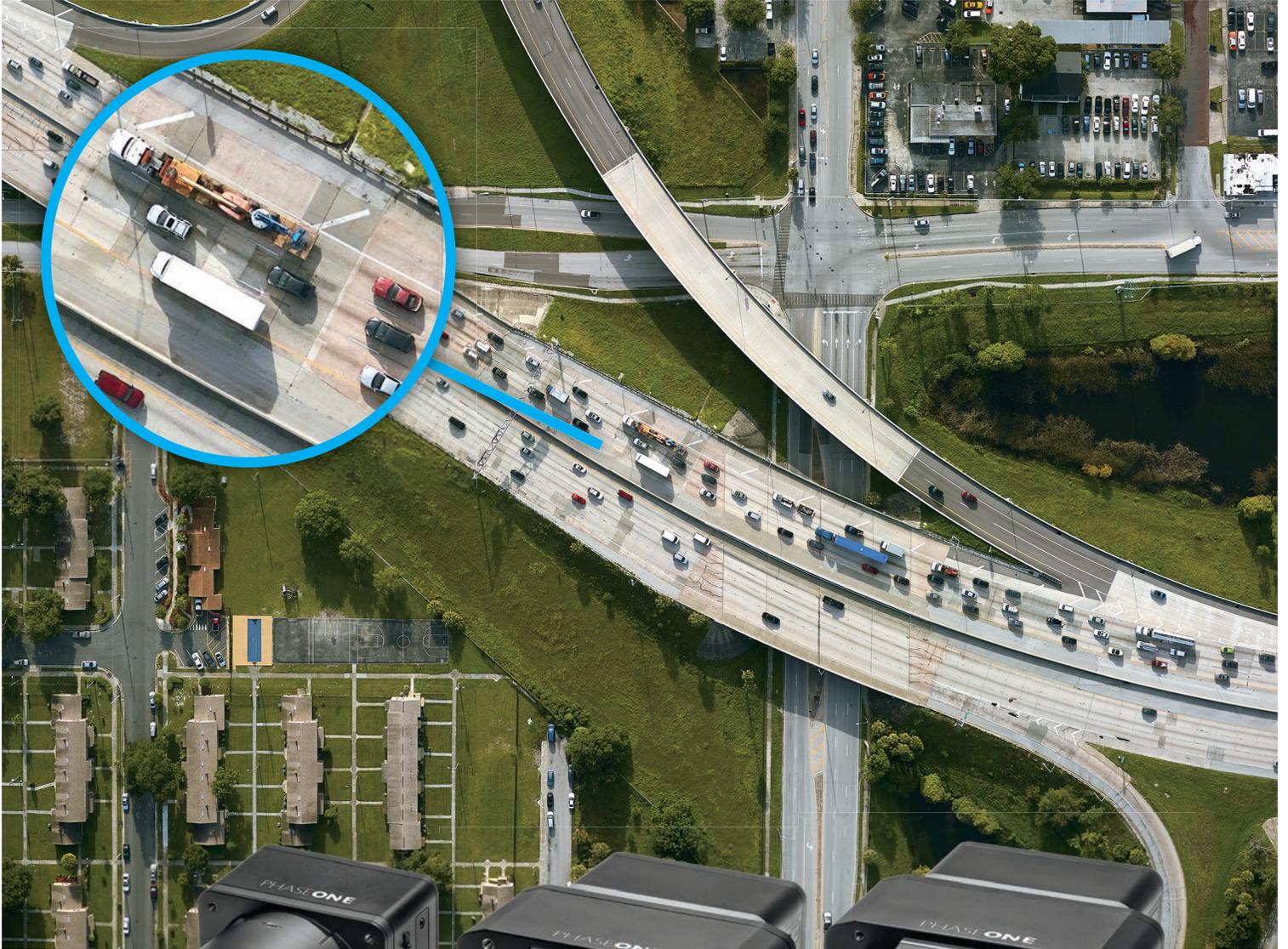
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DEVELOPMENT**
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**COMMISSION 9: VALUATION AND
MANAGEMENT OF REAL ESTATE**
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Results of the International Geospatial Society (IGS) 2014 Member Survey

The IGS is the individual membership arm of the GSDI Association. IGS members have geospatial, spatial data infrastructure (SDI), GIS, spatial enablement or related professional interests. IGS was born in 2009 with 169 founding members and membership has steadily increased since then, with 450 members representing over 70 countries as of 30 August 2014 (Figure 1).

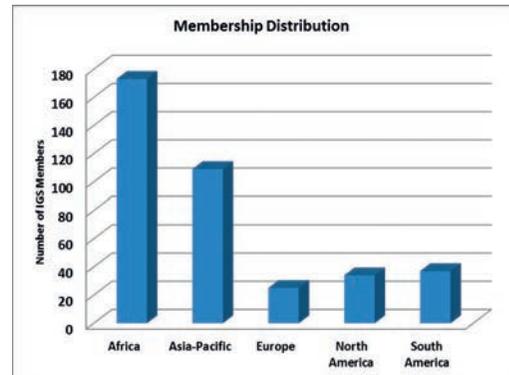
The annual GSDI & IGS member survey was conducted from 24 July to 18 August 2014.

The 227 responses to the online questionnaire represented an overall response rate of more than 45%. The questionnaire was arranged into four parts, with the first part seeking feedback on topics of interest to the membership. Nine

geospatial technology areas were provided and members were asked to choose the four applications of most interest to them. The top five most important application areas were:

1. Sustainable development
2. Disaster prevention, warning, response and recovery
3. Management of the built and natural environment
4. Facilitating land registration and ownership
5. Ensuring food security

Table 1 provides the members' ranking of SDI-related topics for the GSDI Association to focus on in future SDI reports, webinar, on-site workshops and training. The survey revealed that the most important topics were



▲ Figure 1, IGS membership distribution by region.

SDI experiences, case studies and best practices, emerging innovative approaches in SDI education/research, and the role of crowdsourcing and volunteered geographic information (VGI).

The results from this survey will help the Association and IGS to prioritise focus areas for future learning, training and research opportunities.

Sincerest thanks to all IGS members who responded to the survey!

IGS is also in the process of selecting a new president-elect, as Dev Raj Paudyal will assume the presidency from Sives Govender in January 2015 for a period of two years. ◀

Sives Govender, president IGS

✉ sives.govender@gmail.com

Dev Raj Paudyal, president-elect IGS

✉ paudyal@usq.edu.au

Topics	Rank
Experiences and case studies in the use of geospatial technologies as tools in achieving societal goals, e.g. for sustainable development, alleviation of poverty, environmental management, etc.	1
Emerging approaches in providing geospatial education and training	2
Best practices in developing spatial data infrastructure (SDI)	3
Basic and applied research challenges in advancing spatial data infrastructure theory and concepts	4
Experiences and case studies in the implementation of SDIs	5
The role of crowdsourcing in the use of geospatial and mobile technologies in meeting the needs of citizens, government and business	6
The basics: concepts in developing spatial data infrastructure	7
Assessment and measurement methods in determining whether geospatial infrastructure initiatives actually achieve intended goals	8
Overview: standards used in the geospatial industry and their applicability and limitations	9
Overview: technical challenges in design and development of depositories, portals, and registries for geographic data, metadata and services	10
The complementary and competing roles of commercial versus open access geospatial data and services	11
Overview: legal, economic and institutional challenges in implementing spatial data infrastructure	12

▲ Table 1, Spatial data infrastructure (SDI) topics.

More information
www.gsdi.org

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IGS Workshop Celebrates 20 Years of Service

The IAG's International GNSS (Global Navigation Satellite System) Service (IGS) held its biennial workshop from 23-27 June 2014 at the California Institute of Technology in Pasadena, California, USA.

The workshop programme attracted approximately 190 participants and included plenary and poster sessions along with Working-Group and special-topic splinter sessions. IGS members, users and stakeholders reported on recent developments and achievements and discussed solutions to current issues. Special sessions of multiple IGS Working Groups allowed workshop attendees the opportunity to exchange information, debate technical issues, and offer recommendations for improvements to IGS products.

The central theme of the workshop was a celebration of the 20th anniversary of the IGS, which was founded in 1994. Key issues discussed were a demonstration of the enormous success of the IGS so far, and the major challenges ahead – especially with respect to multi-constellation GNSS. All IGS entities, including Analysis Centres, Data Centres, and Working Groups, were encouraged to embrace the multi-GNSS world and to work towards its realisation. It was also recommended that all IGS products take advantage of new multi-GNSS observation data and that a range of related issues be addressed in the coming years so that the IGS can transition to a truly multi-GNSS service in the coming years.

During multiple Working Group discussions of the transition to Receiver Independent Exchange Format (RINEX) version 3, a key recommendation was to develop a transition plan that will integrate RINEX 3, and its



▲ IGS Workshop attendees.

filename convention, into the operational IGS archives by the end of 2015. It was also recommended to provide software tools to support this data conversion to Data and Analysis Centres.

The IGS Real-Time Service¹, which debuted for beta users on 1 April 2013, also held a Working Group meeting. Recommendations included developing a system for an Indo-Pacific moderate density GNSS network, real-time data sharing, and issuing advisory bulletins in accordance with the IAG's Global Geodetic Observing System (GGOS) Theme 2 for natural hazards applications.

The IGS Site Log Manager (SLM) was introduced as the new central repository for station metadata management, and it was recommended that all existing GNSS metadata databases ensure compatibility with the SLM to exchange and maintain metadata correctly.

IGS Working Groups have maintained high standards for the delivery of products, and continue to work on improvements on all aspects of the service. Recommendations

made in support of this include: finalising the IGS contribution to the 2013 International Terrestrial Reference Frame (ITRF2013), encouraging the participation of station operators when selecting future IGS13 Reference Frame stations, developing total electron content fluctuation maps as a new potential official IGS product, encouraging more satellite laser ranging observations of GNSS satellites, and accounting for temporal gravity variations in GNSS orbit determination. The United Nations International GNSS Monitoring and Assessment Task Force also held a meeting during the workshop, in preparation for the ninth meeting of the UN International Committee on GNSS this November in Prague. ◀

More information

Videos and downloads are available at

1. <http://rts.igs.org>
2. www.igs.org/presents

The IGS is evolving as we enter a multi-constellation GNSS world where, in addition to tracking data and products from GPS and GLONASS, the IGS must address the challenges of tracking and analysing observations made by the BeiDou, Galileo and QZSS satellites.



The mission of the Association is the advancement of geodesy.

IGS implements its mission by:

- advancing geodetic theory through research and teaching,
- collecting, analysing and modelling observational data,

- stimulating technological development, and
- providing a consistent representation of the figure, rotation and gravity field of the Earth and planets, and their temporal variations.

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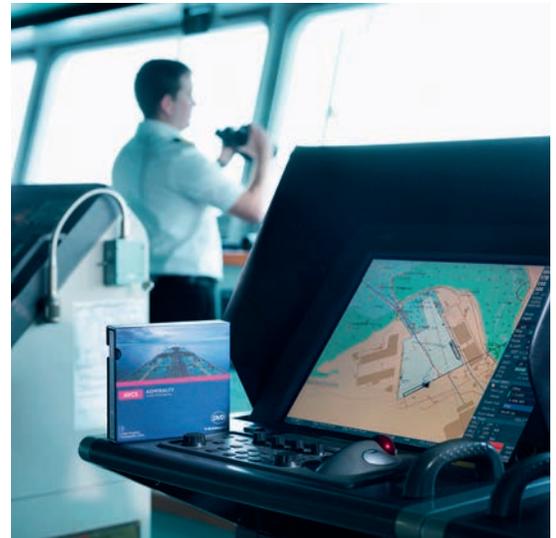


Cartography Out of Sight (of Land)

New uses of the seas have shifted the focus and objectives of hydrographic products from navigation safety to a wider variety of deliverables, motivated by emergent fields like energy production (wind farms, marine turbines), marine environment understanding and protection (habitat mapping, coastal erosion monitoring, coral-reef mapping) and remote sensing bathymetry (using bathymetric Lidar, AUVs, satellite data).

Field operations are now conducted at a wide variety of scales, from detailed port infrastructure inspection survey to regional satellite bathymetry, and these data variants impact on nautical cartographic production and products. Methodologies, equipment and software are becoming more sophisticated and automated. Marine geospatial data management systems, based on multi-sensor raw datasets, are beginning to reshape perceptions of best practices for nautical cartographers. Demand for both qualified hydrographic surveyors and nautical cartographers is increasing. Many hydrographic contracts now demand evidence of formal and appropriate hydrographic and/or cartographic qualifications as a consideration in the evaluation of tender responses. This is accompanied by demands from the personnel themselves for study and continuing professional development opportunities. As technologies change, so too must the way nautical cartographers are educated in order to meet the practice and product requirements of modern hydrographic offices as well as the needs of industry. Furthermore, contemporary educational developments such as blended, direct and distance learning initiatives delivered in a modular fashion are increasing the diversity in education and training. These changes in nautical cartography mean

the continuing revision of accepted international standards in educating people in this field, and it is here that the ICA voice should be heard. Since 2001, ICA has contributed to the overall body which addresses all these concerns. The International Board on Standards of Competence for Hydrographic Surveyors and Nautical Cartographers (IBSC) is charged with accrediting the status of courses which seek professional recognition of their students in hydrographic surveying and nautical cartography. The Board comprises 10 members representing its three constituent organisations: the International Federation of Surveyors (FIG) (4 members); International Hydrographic Organisation (IHO) (4); and ICA (2). Its Secretariat is provided by the International Hydrographic Bureau of the IHO. The Board meets annually and is charged with maintaining both the S-5 (Hydrographic Surveying) and S-8 (Nautical Cartography) standards and considering course curricula submissions. Up to now, 60 programmes in Hydrographic Surveying and/or Nautical Cartography have been recognised. The S-8 Standard recognises two levels of cartographic competence: Category A courses which offer a broad and comprehensive knowledge in all aspects of the theory and practice of a field, and Category B programmes which provide the practical



▲ *Nautical cartography is a critical component of contemporary ship-borne systems.*

comprehension, along with the essential theoretical background, necessary for individuals to carry out the various nautical cartographic tasks. From now on, the Board has decided to strengthen the programme reviews as a process for evaluating and continuously enhancing the quality and currency of the programmes. The evaluation will be conducted through a self-assessment, followed by an on-site consultation by members of the Board. Such on-site visits will raise the profile of both hydrography and nautical cartography, nationally and regionally. The ICA's involvement in these significant developments is critical, especially through the contribution of skills, knowledge, methods and research to the nautical geospatial domains. ◀

Ron Furness (Australia) and Lysandros Tsoulos (Greece)

More information

www.icaci.org



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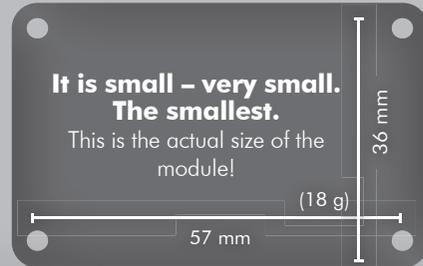
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No 2626

ISPRS at the ICSU General Assembly in Auckland



▲ ISPRS at the 31st General Assembly of ICSU. From left to right: Christian Heipke, Orhan Altan and Chen Jun.

The International Council for Science (ICSU) is a non-governmental organisation with a global membership of national scientific bodies (121 members, representing 141 countries) and International Scientific Unions (33 members). ICSU's mission is to strengthen international science for the benefit of society. Planning and co-ordinating research, science for policy, and strengthening the universality of science are the three key areas of the Council's activities. ICSU is frequently called upon to speak on behalf of the global scientific community and to act as an advisor in matters ranging from the environment to conduct in science. The 31st General Assembly of ICSU held in Auckland, New Zealand, announced the developments at the flagship programme, 'Future Earth'.

ISPRS president Chen Jun and secretary general Christian Heipke participated in the General Assembly and other associated

meetings. The welcome and opening of the General Assembly included an address by the prime minister of New Zealand, Right Honourable John Key. Sir Peter Gluckman, chief science advisor to the prime minister of New Zealand, spoke on 'The changing nature of science; can scientists rise to the challenge'. Besides the normal agenda items, three invited lectures were held: by Nancy Bertler (associate professor, Antarctic Research Centre, Victoria University of Wellington, New Zealand) on 'The potential collapse of the West Antarctic Ice Sheet – implications for global sea level', by Bruce Alberts (chancellor's leadership chair in biochemistry and biophysics for science and education, University of California, San Francisco, USA; former president, US National Academy of Sciences) on 'Spreading science for all', and by Mark C. Quigley (associate professor at the University of Canterbury, UK) on 'Predicting and reducing the impacts of future earthquakes'.

ISPRS AT INTERGEO 2014

As in previous years, ISPRS will once again have a booth (A1.061) on the exhibition floor of this year's Intergео in Berlin. With six of the eight Commission mid-term symposia already finished, the main ISPRS activity is now to prepare for the Congress which will be held in Prague, Czech Republic, in July 2016. To this end, any companies interested in showcasing their latest products and services during the Congress are encouraged to pay a visit to the stand during Intergео or to contact Lena Halounova, Congress director, at lena.halounova@fsv.cvut.cz. During Intergео, Lena is organising an afternoon cocktail session for ISPRS Sustaining Members and representatives of the leading organisations in the field. She and other ISPRS Council Members will be on hand to inform visitors about the work of the Society and the Congress activities.

On 4 September 2014, during the 31st General Assembly of the ICSU, Orhan Altan, the first vice president of ISPRS, was elected to the Executive Board. He was nominated by the Geo-Union cluster of ICSU. It will be his second term of membership on the Executive Board. ISPRS is one of the eight unions of the ICSU's Geo-Union cluster and has played an active role in ICSU activities, such as health and well-being studies and disaster management-related programmes.

Professor Daya Reddy, an internationally recognised mathematician from South Africa, became the new president-elect of the ICSU, and China-Taipei has been selected to host the 32nd General Assembly in 2017. ◀

More information

For detailed information, please visit www.icsu.org.



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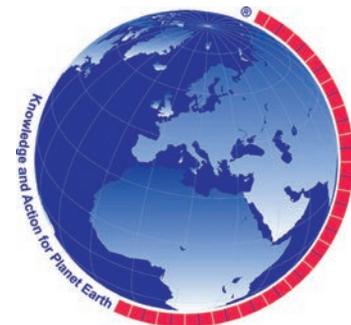
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ISPRS HEADQUARTERS
see address of secretary general

WELCOME TO INTERGEO 2014!



From 7 to 9 October, Intergo is taking place in Berlin, the dynamic capital city of Germany. With a population of over 3.5 million, many sites of historical interest and numerous museums, not to mention countless cafés and restaurants and a lively nightlife, Berlin is the perfect host for this 20th edition of the world's largest geomatics event.

As already mentioned by Olaf Freier, managing director of Hinte – the company that organises Intergo – in last month's issue of *GIM International*, around 35 companies which have been exhibiting since the very start of Intergo will be honoured this year. This *GIM International* Intergo preview highlights many of those companies, along with numerous others. In line with tradition, our guide contains approximately 100 company profiles, providing you a good overview of the latest developments and new products that will be showcased on the exhibition floor. I wish you a very successful Intergo 2014. Enjoy Berlin!

Wim van Wegen, editorial manager

P.S. Are you interested in exploring editorial or advertising opportunities with *GIM International*? Why not stop by our stand, D4.010?!

INTERGEO 2014 PREVIEW

3D LASER MAPPING

3D Laser Mapping is a world-leading developer of laser scanning solutions and provider of geospatial business intelligence, dedicated to making its customers' business a success. The company's highly experienced technical engineering team operates globally through offices in the UK, USA, South Africa and Australia, with a network of specialist distributors, to deliver dedicated, front-line support. Among the high-performance and dependable solutions on display at Intergo will be the StreetMapper Portable, the company's V-Mapper system, and SiteMonitor, the complete slope monitoring solution.

www.3dlasermapping.com
Stand no. A2.026 and FG.009



3D Laser Mapping's main SiteMonitor system, SiteMonitor 4D.

3D REALITYMAPS

3D RealityMaps is a leading service provider for the production of photorealistic 3D city models and 3D visualisation services. 3D RealityMaps

has developed new software tools, which allow completely automated production of photorealistic 3D city models. Model production can be accomplished with images of a single-shot photo flight with overlapping imagery or as a combination of aerial images acquired by nadir and oblique-looking digital aerial camera systems. Automation cuts down production costs significantly. Buildings can be extracted and stored as single objects in various 3D CAD formats including cityGML. A proprietary, extremely powerful software package allows highly efficient visualisation of massive 3D datasets and GIS information layers in real time, even on mobile devices.

www.realitymaps.de

Stand no. D.3054



3D model of Graz created from Ultracam Osprey imagery.

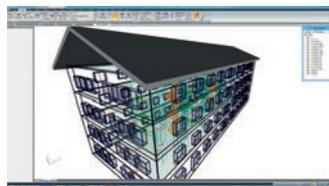
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Offering software that will simplify the work involved in surveying, mapping and design, Adtollo is an experienced software supplier for those who

build society. The company can help professionals in areas such as data co-ordination, drawing and document management, CAD, GIS, mapping and surveying or pure calculation assignments. The company's clients include find contractors, municipalities, governments and consulting firms. Maxim Novikov, Topocad user, describes his experiences with the software as follows: "It is very convenient and flexible software for surveyors in any kind of geodetic work."

www.adtollo.se

Stand no. E1.023



The new interface of Topocad version 15.

AEROSCIENTIFIC

AeroScientific is an Australian company specialising in software and hardware for aerial photographers. The company is new to Intergo and will be demonstrating its flagship products which include Aviatrix, a powerful aerial camera control system, and FlightPlanner, an innovative flight planning tool. AeroScientific's products have

evolved from experience in the surveying industry and are fully customisable and cost-effective. The company aims to make aerial imaging technology accessible to anyone in any industry by making it affordable and simple to use.

www.aeroscientific.com.au

Stand no. A2.031



AeroScientific debuts at Intergo.

AEROSCOUT

Based in Lucerne, Switzerland, the company Aeroscout – originally a spin-off company from the Swiss Federal Institute of Technology (ETH), Zurich – provides industrial, unmanned aerial vehicles (UAVs) with high payload capacity (18kg) and long flight endurance (90min). During the last few years, the Scout B1-100 UAV helicopter has proven to be an attractive UAV platform carrying different kinds of aerial laser scanners combined with highly accurate IMU/DGPS systems. Various demonstrations have already been performed and 3D laser data has been recorded. It is also the Aeroscout

unmanned, autonomously flying Scout B1-100 UAV helicopter carrying the new RIEGL VUX-1 laser scanner. The helicopter will be shown at Intergeo. www.aeroscout.ch

Stand no. B4.002 and A3.014



Aeroscout Scout B1-100 UAV helicopter with RIEGL VUX-1 laser scanner.

AIBOTIX

The Aibot X6 is an innovative flying robot, specifically designed for demanding tasks in surveying and industrial inspection. The intelligent hexacopter reaches virtually any target and automatically flies along routes that are easily planned and programmed from a personal computer. Equipped with a digital camera, it independently takes high-resolution, georeferenced photographs which can be processed into point clouds, orthophotos and 3D models in high density and with great accuracy. At Intergeo, the company will be presenting the Aibot X6 on the ground and in the air!

www.aibotix.com
Stand no. A1.024



With the Aibot X6, surveyors work fast, safe and economically.

ALERION TECHNOLOGIES

Fully customised turnkey unmanned aircraft systems for remote sensing applications: Alerion Technologies develops both fixed-wing and multi-rotor systems that can be outfitted with any existing or future information technologies. The intuitive graphic interface is user-friendly and requires minimal training, making this an ideal platform for difficult and demanding environments. The company's systems have been deployed to study tornados, glaciers and severe thunderstorms, and to map the soil moisture content of agricultural land. Alerion Technologies develops

systems of all sizes that meet the exact requirements of their users. www.aleriontech.co

Stand no. C2.050



Novel soil moisture mapping platform.

ANTCOM

Antcom Corporation is a manufacturer of high-end navigation, positioning, timing and communication antennas for the survey, agriculture, aviation, UAV, military, marine and timing markets. Antcom produces GPS/GNSS, UHF, GSM, ISM, satcom and video/data link antennas. At Intergeo the company will showcase its new G8 GNSS antenna series. It features a distinctive, high-performance quad-feed element, out-of-band filter, limiter and a highly reliable low noise (1.4dB) high gain (43dB) LNA. The G8 series comes in a wide range of form factors and enclosures specifically designed for high-precision geodetic-grade applications, including reference stations, survey, ground, marine, portable and aviation.

www.antcom.com
Stand no. E2.060



G8 GNSS antenna.

ASCENDING TECHNOLOGIES

Ascending Technologies is a manufacturer and innovator of micro UAVs for professional and civil use. With over 1,000 flight systems sold worldwide, the company possesses a unique wealth of experience. Customers benefit from the expertise of this long-standing technology leader in unmanned aerial vehicles and experience innovative quality 'Made in Germany'. The AscTec Falcon 8 with AscTec Trinity technology is now available (Q4/2014) and offers the following advantages: highest safety by up to 3 times redundant electronics

and components, great ground coverage and cost-efficiency in daily work. This technology heralds a new era of flight control.

www.ascotec.de
Stand no. B2.001 and FG.007



AscTec Falcon 8 + AscTec Trinity.

BLACKBRIDGE

BlackBridge provides end-to-end solutions across the geospatial value chain. This includes satellite operations, data-centre and geocloud solutions, and worldwide satellite imagery distribution through over 100 BlackBridge partners, combined with the creation of value-added products and services. At Intergeo, visitors can talk with the team about BlackBridge products and services, or see one of the company's on-site presentations. A highlight will be new RapidEye Persistent Change Monitoring (PCM), including demonstrations of how it can be used to efficiently and cost-effectively update large, complex geospatial datasets.

www.blackbridge.com
Stand no. A3.054



Berlin, Germany, acquired on 4 September 2014.

BRADAR

At Intergeo 2014, Bradar will launch its new and innovative airborne dual (X and P) band interferometric radar, the BradarSAR 3000. Its main features are: high-resolution, dual-band radar, simultaneous recording in X and P band, ideally employed in low operational cost platforms, integration with optical (visible and IR) sensors possible, capable of gathering data below the foliage, possibility of operation at night and with cloud cover, light weight and compact, it can be easily adapted into aircrafts

already certified for photogrammetry. www.bradar.com.br
Stand no. C3.006



BradarSAR 3000.

CARLSON SOFTWARE

Providing new and improved hardware and software to both speed up and ease users' work and upgrading traditional offerings has kept Carlson Software busy this year. Visit the company at Intergeo to learn more about the newest version of Carlson SurVCE (Fast Survey). Visitors can both see and try out the all-new BRx5 GNSS receiver and another surprise hardware offering from Carlson. In addition, it will be possible to receive one-on-one demonstrations of Carlson's newly released software — Survey, Civil, Construction, Takeoff, and more — as well as special new software releases to be announced at the show.

www.carlsonsw.com
Stand no. B1.037



Carlson GNSS receiver in the field.

C-ASTRAL

C-Astral Aerospace unmanned systems are completing tasks as diverse as improvised explosive devices (IED) identification & change detection in Afghanistan to precision agriculture and farm management, mining, power line planning, pipeline monitoring, road building, animal counts, forestry management and volume calculations in the Arctic, Africa, Australia, New Zealand, Europe, Asia, North America and South America. Operational on all continents, the BRAMOR gEO family of UAS is in constant evolution as a top-of-the-line surveying system, now being complemented with the new

Welcome to visit FOIF
at INTERGEO 2014
Stand No: Hall 1 C1.010



Total Station



GNSS



GIS



Gyroscope



Levels

New products will be demonstrated at Intergeo 2014

- A50 New Generation GNSS Receiver
- RTS1002 Motor Total Station
- RTS340 Total Station
- DT402-Z Auto-collimating Digital Theodolite
- EL03 High Precision Digital Level
-for more, welcome to FOIF stand and find them



BRAMOR gEO-R RTK system, which will be launched at Intergeo 2014, capable of survey results that are an order of magnitude better than those of the competition.

www.c-astral.com

Stand no. C1.034



C-Astral BRAMOR gEO 3.

CHC

CHC Navigation designs, manufactures and markets a wide range of professional GPS/GNSS solutions in more than 50 countries. The CHC X91+ brings together world-leading GNSS technology, rugged field computer with seamless corrections management and versatile data collection software. The X91 GNSS is the perfect choice for demanding survey and construction applications requiring high accuracy and reliability.

www.chcnav.com

Stand no. D2.058



CHC X91+.

COMNAV

Located in Shanghai, in the economic centre of China, ComNav Technology develops and manufactures multi-constellation, multi-frequency GNSS measurement engine boards and receivers for ultimate high-precision positioning applications. ComNav is also the very first Chinese company to develop, design and produce combined GNSS (GPS and GLONASS) plus BeiDou OEM boards. ComNav is bringing some new GNSS OEM products to Intergeo this year for high-precision applications. In addition, ComNav will display its innovations on the geoinformation market by introducing a number of new, integrated products and applications.

www.comnavtech.com

Stand no. C1.016



T300 GNSS receiver.

DIAMOND AIRBORNE SENSING

Austrian company Diamond Airborne Sensing enjoys a unique worldwide status as the leading provider of all-in-one sensor solutions delivered directly from the aircraft manufacturer. The DA42 MPP is the most capable aircraft in its class with an incredible endurance of up to 12 hours while burning only 6.4 US Gal. Powered with turbo-diesel engines (AE300 from Austro Engine), capable of using different fuel grades, it offers ultimate deployment flexibility. Diamond's DA42 MPP GEOSTAR is available with hyper spectral detection capabilities or for collecting laser scanning and photogrammetry data during one single flight. At Intergeo 2014, the company is presenting solutions for surveying cities, land areas, critical infrastructure, glaciers or snow fields, mineralogy or environmental applications and also for mapping damage caused by natural disasters.

www.diamond-sensing.com

Stand no. A3.004



DA42 MPP GEOSTAR.

DIELMO 3D

DIELMO 3D has more than ten years' experience of developing GIS software tools and processing data. The ability to adjust its software to provide customised Lidar and GIS solutions enables the company to bring the best expert solutions to any project. It aims to inspire customers with ways to get more from their data. The company's most in-demand services and solutions are: power lines and offending vegetation projects, basic and advanced Lidar processing services, 2D/3D GIS web portals, and exclusive servers for Lidar and Geospatial data.

www.dielmo.com

Stand no. C1.001

DRONEMETREX

DroneMetrex specialises in photogrammetric mapping using TopoDrones. DroneMetrex first developed the true UAV mapping system based on photogrammetric principles and only then adapted it to an airframe. The TopoDrones capture aerial data with unsurpassed accuracy: 10mm horizontal and better than 25mm in height. Intergeo visitors can see the TopoDrone-100 and learn about its unique features, which include: dynamic-stabilised active mount to ensure near-nadir position of each with no 'crab'; calibrated mapping camera with Zeiss lens; direct georeferencing solution – mapping without ground control; and NIR imagery and mapping under water from the same camera.

www.dronemetrex.com

Stand no. B4.058



TopoDrone-100.

E-CAPTURE

e-Capture R&D, a technology-based company, intends to revolutionise the world of measuring with a new generation of portable, easy-to-use and highly accurate instruments. e-Capture R&D introduces a new 3D measuring instrument, embedded in a powerful tablet called EyesMap. EyesMap unites the capabilities of surveying instruments and 3D scanners, and is optimal for most architecture and civil engineering jobs. EyesMap measures coordinates, surfaces and volumes and scans advanced photogrammetric colour pictures to create 3D models of all kinds of differently sized objects: from small insects to large buildings or wide landscapes, as well as the movement of animals or people, indoors or outdoors.

www.ecapture.es

Stand no. C3.058



EyesMap.

ETERNIX

Eternix is a leading software company, developing high-performance visualisation and GIS editing products. The company's products are oriented towards GIS professionals, enabling processing, re-projection and manipulation of files of virtually any size and format, in real time, without pre-processing. The Blaze product family includes several applications and complementary extensions, delivering outstanding performance and unparalleled usability. At Intergeo 2014, the company will be presenting new features such as high-quality publishing of 3D geospatial PDF files, a new geocataloguing mechanism for extensive datasets, and more advanced capabilities which will be revealed at the stand.

www.eternix.co.il

Stand no. B2.020

EXELIS

Exelis Visual Information Solutions provides software solutions to help users turn geospatial imagery into useful information for their GIS. The ENVI products are seamlessly integrated into ArcGIS, making it easy to create knowledge from multispectral and hyperspectral imagery and Lidar and SAR data on the desktop, for mobile devices, and in the cloud. Visitors to the Exelis booth will see how easily information can be added from remotely sensed imagery to the GIS. To learn more about Earth Observation sensors and operational applications, visitors can register for the company's Remote Sensing Workshop on 8 October from 2.30pm to 5.30pm.

www.exelisivis.eu

Stand no. B3.936

FOIF

FOIF is taking its latest products and technologies to Intergeo 2014, such as the new-generation RTK receiver A50, a compact, lightweight and easy-to-handle receiver, with new features including Wi-Fi, USB OTG and a tilt sensor. The company's RTS340 total station is equipped with a highlight colour display (QVGA), which allows the user to see the display clearly even in bright conditions. The DT402-Z theodolite

ScanLook 2.0

'Snoopy'



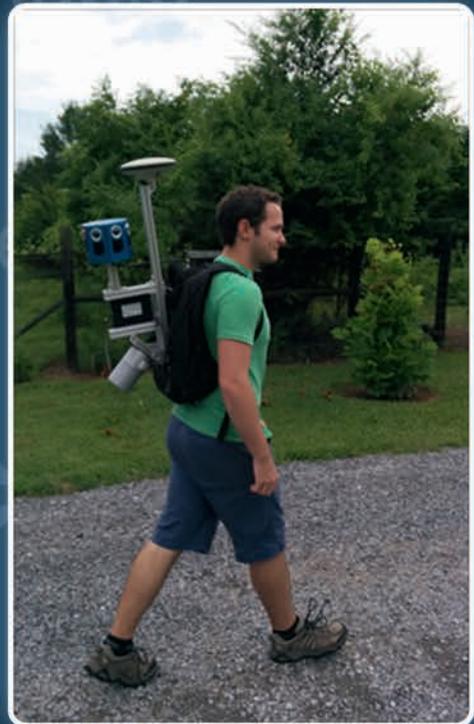
FARO X330



Velodyne VLP-16



Velodyne HD-32



Backpack Mapping System

www. **LIDARUSA** .com

System

telescope integrates a collimation device; it can detect small changes of inclination in the object or evaluate differences in the inclination of different parts of the object.

www.foif.com

Stand no. C1.010



RTS340 total station.

FUGRO GEOSPATIAL

Fugro specialises in innovative, high-resolution survey services and solutions. These services include airborne and satellite imaging, photogrammetry, 3D city models, Lidar, terrestrial scanning and land-based surveying. At Intergo 2014 the company will be showcasing Fugro's RILA and ROAMES services. RILA is a unique tool that is used to measure, compute and present rail geometry information in a safe and cost-effective manner. The RILA unit piggybacks on the rear of a regular service train and collects positioning data, making it highly affordable in comparison to traditional track surveys. Fugro's ROAMES service is an innovative solution for the energy and infrastructure sectors that rapidly generates a precise, high-resolution in-situ 3D model of an asset in its real-world context extracting targeted features such as electricity distribution power lines, poles and surrounding vegetation.

www.fugrogeospatial.com

Stand no. C2.042



Fugro delivers complete, end-to-end solutions.

GENEQ

Since 1972, Geneq has been specialising in providing state-of-the-art scientific instrumentation to the Canadian industry. For the last

20 years, the company has been a leading supplier of GNSS receivers and field data collection solutions through its geomatics department. In 2003, Geneq introduced its own brand of real-time GPS receivers with the SXBlue GPS family, the world's first sub-metre Bluetooth receiver. With revolutionary Canadian technology, the SXBlue GPS is also the first GIS/mapping-grade receiver to achieve sub-metre 2dRMS (95%) in real time, no post-processing. The receivers use the SBAS signal to its full potential and as the sole source of differential correction. In 2013, Geneq introduced the world's first Bluetooth GNSS receivers pairing with iPads and iPhones, the iSXBlue II GNSS (sub-metre) and the iSXBlue III GNSS (centimetre). Windows and Android are compatible, of course.

www.sxbluegps.com

Stand no. C2.036



The new iSXBLUE II GNSS Bluetooth receiver.

GEODIS

GEODIS has been a star of the international geoinformation market for 24 years. The company continually offers new projects that represent unique solutions for working with data, supported by an enthusiastic team of professionals. It has a fleet of 7 own aircraft and employs 200 employees in 13 countries. Customers include ministries, cadastral agencies, public authorities and local governments (counties, cities, villages, regions), energy and telecommunications companies, IT solution providers, construction and development companies and design offices.

www.geodis.cz

Stand no. A6.011



3D model of Tatra mountains.

GEOSUN

Geosun is a professional manufacturer focused on GNSS instruments, software and systems similar to Trimble, Leica and Topcon. The company's products are designed to meet high quality standards while offering low-cost solutions for the survey industry. The company provides complete solutions for different customers with its range of GNSS hardware and software products, including GIS data collectors, handheld GNSS RTK systems, UAV high-performance aerial GNSS receivers, GNSS receivers, Geosun CORS systems, GNSS/INS integrated positioning and orientation systems, high-precision GNSS real-time deformation monitoring systems, etc. The company holds full intellectual property rights for all its products.

www.geosun-gnss.com

Stand no. A4.011



High-performance GNSS receiver.

GERMAP

Despite still being a young company in the geomatics domain, GerMAP can draw on each of its founders' 25-plus years of professional experience. Special areas of interest are UAV mapping technology, aerial image data processing, and handling complex projects. For the UAV mapping segment, GerMAP develops, sells and applies unmanned aerial vehicle systems which execute aerial imaging flight missions fully automatically. Training and maintenance are also part of GerMAP's UAV mapping sales portfolio. Other core competences of GerMAP's engineers including processing aerial images, whether they originate from UAV platforms or manned aircraft, and the generation of orthoimages (true orthos as well as regular orthos), terrain and surface models, volumes, contours and other spatial information.

www.germap.com

Stand no. D3.040

GEXCEL

Gexcel has a rich history spanning more than 10 years of proven fully featured Lidar and imagery analysis software with the JRC 3D Reconstructor and PointR3, tailored for terrestrial, mobile and airborne scanners such as Faro, Optech, Riegl, Stonex, Topcon, Trimble and Z+F. Gexcel also provides hardware/software-integrated solutions for mobile mapping, mine monitoring, vertical structures and 'as built' analysis. Visitors to the Gexcel stand will see: OPMMS (open pit mine monitoring system) for automatic/manual long-range profiling of open pit slopes and surfaces, for ILRIS TLS, and SCAN ARMOR rugged enclosure to protect and remotely control the Focus3D.

www.gexcel.it

Stand no. C4.001



The new OPMMS solution.

GRAEBERT

Graebert is a leading developer of custom CAD software, solutions and services. The SiteMaster unique surveying solutions and services enable the company to survey on a worldwide basis and ensure that there is consistency with and conformity to clients' specifications. At Intergo, visitors can see the new SiteMaster product range. SiteMaster BIM makes it easy to create fully object-orientated 3D models using only a handheld laser distance meter, which can be exported in IFC format. This offers cost and speed advantages compared to other building measuring methods.

www.graebert.com

Stand no. C1.029



SiteMaster integrates 3D viewing and BIM.

HANDHELD

The all-new NAUTIZ X8, which will be shown at Intergo, is an ultra-rugged

COMMUNICATION AT YOUR FINGER TIPS.



The XDL Rover 2™ UHF receiver is equipped with Bluetooth® technology for wireless communication of RTK corrections to similarly enabled GNSS receivers. You can install Pacific Crest's Android™ app on a Bluetooth phone to easily configure the XDL Rover 2 in the field.

This pocket-sized radio also allows cable-free operation and features an internal, rechargeable battery for ease of use and portability for more than 10 hours per charge. The XDL Rover 2 is backward compatible with existing Pacific Crest and other RTK radios operating in the 403 to 473 MHz range.

Step up to the performance you need at www.PacificCrest.com



PACIFIC CREST®



Visit us at Intergeo
in the Trimble U.S.
Stand C3.053

handheld with superior processing power, screen performance and battery life. It is IP67-rated and built for rough use by field workers primarily in GIS, land surveying, public safety, forestry and the military. The NAUTIZ X8 features a high-performance Texas Instruments 4470 dual-core 1.5GHz processor. It has 1GB of RAM, 4GB of iNAND Flash and a 5200mAh Li-ion battery that lasts up to 12 hours on a single charge. The large 4.7-inch ultra-bright capacitive multi-touch screen with chemically strengthened glass gives users unparalleled brightness in any field condition. Operating systems are Android or Windows Embedded Handheld 6.5.3.

www.handheldgroup.com

Stand no. A2.002



Handheld NAUTIZ X8.

HEIGHT-TECH

Height-Tech flight systems are the result of years of research and development and a wealth of experience in the area of technical inspection and media productions from the air. Drones equipped with the appropriate sensor and camera technology are superbly suited for rapid and economic surveying. Height-Tech drones use photographic systems providing a ground resolution of a few millimetres and delivering a quality far superior to customary (manned) overflights or satellite images. With automatic GPS-controlled flight paths, overlapping photos are taken that allows anything from mosaic or orthophoto compilation and georeferencing to high-resolution 3D surface models (point clouds).

www.heighttech.com

Stand A4.026



Height-Tech HT-8 C10.

HI-TARGET

Hi-Target will be present at Intergo 2014 to showcase its latest products. The company has several activities to offer to Intergo visitors, such as a RTK total station product introduction, and Polaroid instant photography including free gifts.

Stand no. B4.026

www.hi-target.com.cn



One of the latest Hi-Target products.

HORIZON

Horizon is pleased to announce that it has been selected as the supplier for one of the largest tender requirements in the industry. The company will be supplying 520 units of Kronos 200M receivers and 100x HTS-582M total stations, along with other survey accessories, to the Settlement and Land Records Department in Myanmar by November 2014. Horizon will be launching a victory promotion for selected products at Intergo 2014. All enquiries are welcome.

www.horizon.sg

Stand no. C2.040



Kronos 200.

HORUS VIEW AND EXPLORE

Horus delivers software for a video-based mobile mapping platform. It is the company mission to support working in and communicating through images regarding the public space globally – because everyone understands images and it is faster, easier and cheaper. Existing sensors can be combined or GIS/CAD can be added to the video. Visitors to Intergo can watch the turnkey video solutions at the company booth outside or watch the power of adding imagery at the indoor stand.

www.horus.nu

Stand no. E1.062 and FG.004



Horus Movie Player.

ICAROS

Icaros, a leading provider of advanced aerial remote sensing and 3D visualisation solutions, will be showcasing its IDM1000 oblique sensor system at Intergo. The company will also introduce new proprietary software – the Icaros Measurement Tool (IMT), a software add-in to ArcGIS. Visitors can gain an up-close look at this exciting new technology on the company's stand. Icaros will also have an IDM1000 sensor system and software demos available on site at the conference.

www.icaros.us

Stand no. A4.009



IMT provides accurate height, length, area and façade measurements.

IMAJING

imajing is an international designer of portable mobile mapping systems which aims at bringing simplicity to field data collection. Through a high level of integration, innovative positioning and image processing technologies, imajing has chosen to size its products to give flexibility and ease-of-use to its clients. At Intergo 2014 imajing will present its brand-new range of mobile mappers imajbox, its GIS production software suite imajview and its turnkey web service solution imajnet. Through this tool chain, imajing gives life to GIS and solutions for transportation network asset management.

www.imajing.eu

Stand no. C3.032



imajbox, stand-alone and connected.

JOSEF ATTENBERGER

Josef Attenberger is one of Europe's leading dealers for marking and surveying equipment and accessories. Intergo visitors can have a look at total stations with standard and robotic instruments from Spectra Precision and Geomax, get excited about the new Altus GNSS receiver APS-NR2, or obtain their locator equipment from C.Scope or Subsurface, even for detecting plastic pipes. All the equipment can be tested at the booth. VarioPlus is the only patented German marking system with two parts. Visitors are encouraged to ask about the new products!

www.attenberger.de

Stand no. A 1.060



Altus GNSS receiver APS-NR2.

JUNIPER SYSTEMS

Juniper Systems designs and manufactures the highest-quality rugged data collectors in the industry for geomatics professionals who need reliable GNSS, extra-long battery life, superb display visibility and an ultra-rugged design. The company's newest handheld product will be debuting at Intergo for the first time! Geomatics professionals rely on Juniper Systems' rugged data collectors for improved productivity and data accuracy. More details about Juniper Systems' products can be found on the company's website.

www.junipersys.com

Stand no. A2.039



Juniper Systems' rugged data collector.

KANSAI CONSTRUCTION SURVEY

To keep up with the times, Japanese company Kansai Construction Survey conducted research and came up with advanced solutions for total stations which have never existed before. The unique systems,

COMNAV

T300 GNSS Receiver



Easy to use

Super light (less than 1 kg with two batteries)

GPS L1/L2/L5, BeiDou B1/B2/B3, GLONASS L1/L2

Built in Tx&Rx

Ultra small

Hot swappable battery design

Compatible with other brands GNSS RTK

Many user-friendly conveniences built in

Low power consumption

Choose Right, Measure Right!



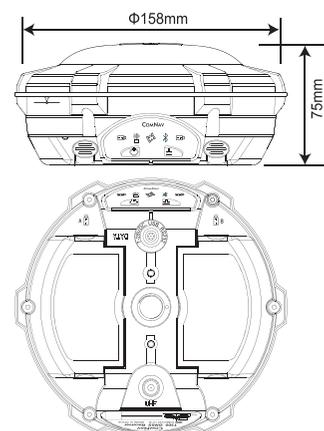
INTERGEO 2014

October 7-9, 2014

Berlin, Germany

ComNav Booth Number: C1.016

With decades' experience on the surveying GNSS receiver, the T300 is an ultra small and light product which combines lots of market proved advantages together. It could track all the working GNSS constellations. By using ComNav's unique QUAN™ algorithm technology, it could work as RTK mode by using any single GNSS constellation such as GLONASS or BeiDou. The strong anti-interference ability of the receiver makes it possible to work in any environment. It frees surveyors to do the work in any place.



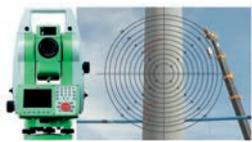
ComNav Technology Ltd.

www.comnavtech.com

named KUMONOS and Baum Station, were born from the idea of taking care of infrastructure from its birth to the very last moments of its lifespan. KUMONOS is a new optical system with built-in scale for crack measurements. Baum is also a new reticle for total stations, enabling measurement of radii and central coordinates of cylindrical objects such as poles, piles and suchlike from a distance.

www.kankou.co.jp

Stand no. B1.065



Baum Station.

KOLIDA

Kolida Instrument is a leading manufacturer of precision surveying equipment. It offers a large collection of GPS and GNSS systems, total stations, lasers, optical instruments and software for surveying and civil engineering applications. Kolida is dedicated to developing quality products and providing fast, efficient service to customers. Kolida products are currently used in over 70 countries around the world. At Intergo 2014, Kolida is bringing two new products to users: total station KTS-462R8, with 800 prismless measurement range, auto pressure/temperature sensor and colourful LCD screen; and K96T, a rugged and intelligent GNSS receiver which integrates the latest positioning technology.

www.kolidainstrument.com

Stand no. C4.021



K96T GNSS receiver.

LEAD'AIR

Lead'Air, based in Orlando, Florida, USA, has taken over the design and manufacturing of all the equipment which was previously produced by Track'Air BV in The Netherlands. Track'Air is now the trademark used

for all Lead 'Air's products. At Intergo, Lead'Air will be presenting its new range of Midas oblique camera systems, the RedBaron 80mp single camera mapping system derived from the Phaseone IXA180, the Nexttrack2 flight management system using state-of-the-art mobile flight guidance and allowing aircrews to take advantage of their favourite mobile devices to carry out survey missions.

www.trackair.com

Stand no. A4.033



RedBaron.

LEICA GEOSYSTEMS

Leica Geosystems, the leading expert in geospatial measurement, is proud to present its latest product ranges. These include solutions for topographic and engineering surveying, GIS, GNSS, airborne data acquisition and processing, as well as construction. The most recent product innovations include Leica ALS80, the next generation of airborne Lidar solutions, Leica Cyclone 9.0, high-efficiency point cloud processing software and Leica GeoMos Now!, a web-based application with real-time access for informed decision-making. Leica Geosystems is trusted by professionals worldwide, providing state-of-the-art equipment with high accuracy, ease of use, reliability and ongoing service and support to customers.

www.leica-geosystems.com

Stand no. A1.024



Leica ALS80 airborne scanner.

LIZARDQ

The LizardQ high-resolution panoramic camera will be shown for the first time at Intergo. Full spherical images enhance 3D laser scanning or

can be employed stand-alone. LizardQ offers superior image quality through professional DSLR camera technology and the HDR process, is faster than a laser scanner and straightforward to operate. Also on display for the first time: Visual Content Management (VCM) software by BORUFA. VCM combines full spherical images with floor plans, photos, videos, PDF documents and external data sources to create a navigable presentation of a site or building.

www.lizardq.com

Stand no. A4.022



LizardQ high-resolution panoramic camera.

LUPOS3D

Whether in the field of laser scanning, photogrammetry or software development, Lupos3D provides a range of impressive 3D measuring solutions. At Intergo the company will present its software solution LupoScan, which is designed to enable easy and efficient extraction of required information from laser scanning data – and it supports almost every laser scanning system. Various export formats and direct CAD interfaces guarantee a high compatibility with other programs. LupoScan is a highly effective and affordable tool suitable for both beginners and experienced users.

www.lupos3d.de

Stand no. D2.040



Analysis of point clouds with LupoScan.

MENA3D

As a leading company in 3D measurement, Mena3D offers complete 3D measurement and geospatial solutions for a broad range of applications. Mena3D's strength is its knowledge of 3D technology and

expertise in 3D market development, especially in the Middle East and North Africa. The company focuses on offering solutions and support that enable customers to accelerate their product quality and productivity. Mena3D is Europe-based company, headquartered in Frankfurt, Germany.

www.mena3d.com

Stand no. C2.039



Fully autonomous UAV.

METASENSING

MetaSensing is an innovative remote sensing company whose expertise lies in the design and development of compact, high-resolution and cost-effective SAR and RAR sensors, for both airborne and ground-based solutions, supported by correlated services. MetaSensing will display its state-of-the-art instrument for monitoring deformation and vibration of unstable natural elements and critical manmade structures, the FastGB SAR. Thanks to its unique design, the sensor is compact, easy to install and can operate in harsh working conditions. At the stand, Intergo visitors will find more information regarding the FastGB SAR and the company's broad range of radars for different applications.

www.metasensing.com

Stand no. B2.012



FastGB SAR.

MICROSOFT

Established through Microsoft's 2006 acquisition of Vexcel Imaging, Microsoft's UltraCam business unit is a leading provider of digital aerial cameras and brings more than two decades of photogrammetry expertise to Microsoft's Bing Maps business. In early 2014, Microsoft's UltraCam business unit introduced an updated version of the UltraCam Osprey, a

"MEET THE SOLUTION, S AND FORGE SERIES"



"SOLUTION FOR YOU"

- Paired Solution with more usability and flexibility
- GeoMobileSolution: Most cost-effective GIS application
- The GMS 8 and 9 are now fully integrated with Effigis' EZSurv GNSS post-processing software
- GeoAssist provides Raw data logging, Ntrip, RINEX converter, Kinematic measurement, User Profile selection....
- Flint and Forge are both stable and efficiency handheld GPS devices with autonomous 1M ~ 3M accuracy.



"EMBRACE THE SOLUTION"

- Highly Customization capability handheld unit: Forge
- RFID reader, Barcode Reader,
- L1/L2 GPS, GLONASS, SBAS and BeiDou, up to 120 Channels
- Long range Bluetooth communication distance up to 1 kilometer
- First ultrasound integrated handheld device for Forestry solution
- SDRAM 512 and 8 GB iNAND
- NMEA and Raw data available
- E-compass/G-sensor/Gyro
- IP 67

BAP
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No 2642



www.kqgeo.com
Email:simon.yao@kqgeo.com
Tel: 86-10-85271488
FAX: 86-10-85271489



M8

GPS+GLONASS+BDS
Field Mapping System



No 2629

digital aerial system that combines a high-performing photogrammetric nadir camera with oblique image capture capabilities. Intergeo offers visitors the opportunity to see the latest photogrammetric technology innovations from Microsoft's UltraCam Group.

www.microsoft.com/ultracam

Stand no. A4.014



UltraCam product family.

MOSAICMILL

MosaicMill is a Finnish company specialising in remote sensing and photogrammetric tools. MosaicMill develops and distributes both UAV and manned EnsoMOSAIC aerial survey solutions. MosaicMill also distributes EnsoMOSAIC NDVI and Rikola Hyperspectral cameras for natural resource mapping. At Intergeo 2014 MosaicMill will show EnsoMOSAIC Cropdrone – complete system for precision agriculture. MosaicMill will also demonstrate new photogrammetric methodology for 3D electricity line monitoring.

www.mosaicmill.com

Stand no. D1.035



EnsoMOSAIC Cropdrone for precision agriculture.

NAZCA IT SOLUTIONS

Nazca IT Solutions supports enterprises or organisations that need quick access to company-relevant, up-to-date, geospecific information for the performance of management tasks and logistical processes. Based in The Netherlands, the IT company develops innovative IT solutions for national and international authorities and organisations. The focus at this year's Intergeo will be on 'Sensing City', dealing with the question of how to combine and disclose digital data streams (i.e. cadastre, service providers, big data, sensor

grids) to aid city management and infrastructure development, and to encourage citizen participation.

www.nazcai.nl

Stand no. E1.030



Nazca is focusing on 'Sensing City' at this year's Intergeo.

OPTECH

Celebrating 40 years of leadership in Lidar technology, Optech provides leading airborne Lidar solutions such as the Galaxy with its continuous operating envelope and PulseTRAK technology, Orion for corridor surveying, and the award-winning CZMIL bathymetric system. On the ground, the mobile Lynx scans accurately at cruising speeds and the Optech ILRIS collects detailed data at extreme ranges while integrating UAV photogrammetry. Optech workflows offer intuitive planning tools, real-time results for in-field QA, and automated processing delivering high-quality data. At Intergeo 2014, Optech will explain the benefits of these innovative new sensor developments.

www.optech.com

Stand no. D4.021



Optech Galaxy.

P3D SYSTEMS

At Intergeo 2014 in Berlin, p3d systems is showing the new ProScan system, the world's first kinematic laser scanning solution, which allows 3D data to be captured with high accuracy and an unparalleled productivity for outdoor and indoor applications. With the recent integration of Leica's P20 laser scanner, the ProScan supports the world's leading terrestrial laser scanners and turns them into highly efficient, flexible 3D capturing solutions with an increase in

productivity by factors. The easy operation of the system and the highly automated data processing with the p3dSW makes the entire system easy to learn and highly productive. p3d systems will demo the ProScan and the p3dSW live during the exhibition and will showcase the results of many current projects.

www.p3dsystems.com

Stand no. A1.015



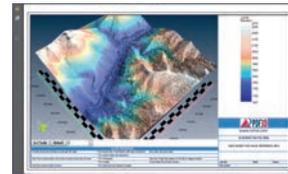
ProScan system.

PDF3D

For Intergeo visitors who are looking to simplify workflows and easily share reports, models or project results, PDF3D supplies the solution with a fully interactive, geospatially enabled, collaborative platform that allows those working within survey, engineering, geospatial and geophysical environments publish to the ubiquitous PDF format. From mapping and laser scanning to Lidar, point cloud and complex modelling, PDF3D's 3D PDF conversion software and plug-ins work seamlessly with numerous GIS workflows used in Earth science communities globally.

www.pdf3d.com

Stand no. B4.007



The PDF3D platform.

PHASE ONE

Phase One Industrial is introducing a camera platform, the iXA-R series of cameras and the iX Controller at Intergeo. The iXA-R cameras share many of the same features as the successful iXA aerial cameras, including: focal plane and central leaf shutters, optional Forward Motion Compensation, scalability to form multi-camera arrays as well as easy integration with popular flight management systems and GPS/IMU receivers. The new iXA-R cameras

expand the iXA lens range by adding three new dedicated Rodenstock lenses with focal lengths of 40mm, 50mm and 70mm.

<http://industrial.phaseone.com>

Stand no. C4.065

PIX4D

At Intergeo, Pix4D is presenting the latest Pix4Dmapper features including multiple GPU-powered processing and its new multi-camera rig feature for streamlined processing of multi-camera systems. This innovation allows automatic processing of oblique camera systems or multi-spectral sensor array. Pix4Dmapper supports many existing camera rig systems and lets users configure their custom rigs directly in the software. Visitors can also learn all about additional new features of Pix4Dmapper, such as textured 3D meshes and improved object detection and annotation. The company is encouraging attendees to (re)discover the most innovative and easy-to-use image processing software available on the market.

www.pix4d.com

Stand no. C2.031

POINT GREY

Point Grey will be showcasing the Ladybug 5 spherical imaging camera streaming 30MP, 12bit panoramic video in real time using 6 x 5MP Sony CCD sensors. Precision factory calibration, 100% user-controlled image processing, a 5Gbit/s USB 3.0 interface and a groundbreaking post-processing workflow, for superb image quality and high dynamic range, make the Ladybug5 ideal for GIS applications. Visitors will also see the new Grasshopper3 USB3 Vision camera models featuring high-resolution 9.1MP using the Sony ICX814 EXview HAD CCD II sensor and Sony's IMX174 2.3MP sensor that demonstrate the benefits of CMOS and CCD with global shutter technology.

www.ptgrey.com

Stand no. C2.011

Carlson BRx5 GNSS Receiver

— Be outstanding in your field!

Featuring Carlson Exclusive LDL:

(live digital level)

Carlson SurvCE 4.0 utilizes the BRx5's internal level sensors to display a live digital level bubble in the store points and stake points screen. Plus —

- Fully integrated 270-channel GNSS receiver with UHF radio & GSM cell modem
- Each receiver can be configured as Base, Rover, or Network Rover
- Dual Bluetooth Ports – connects data collector & cell phone
- Dual Hot-Swap Batteries – no need to stop work to recharge or replace battery packs
- OmniSTAR Capable – submeter differential correction available worldwide

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Stand: B1.037

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LON: 83°47'00.59"

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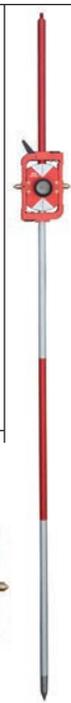
(Found in 2002)



New GTS342R5A Prismless Total Station



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- * 3.5" / 320x240dpi colour LCD touch screen
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New compacted Prismless Total Station



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email: geoallen@vip.163.com

fax: +86-512-6862-9776

tel: +86-512-6802-6320

GEOALLEN CO., LTD.

No 2639



Ladybug5.

PRONIVO

proNIVO Messgeräte Handels GmbH offers a large range of tripods and accessories to dealers worldwide. Due to its global manufacturer network, the company can offer high quality and very competitive prices. The latest fibreglass tripod features both quick lock and wing screws for maximum safety for end customers. Accessories include prisms, poles, rods, nails and much more. Visitors are encouraged to ask for special discounts!

www.pronivo.de

Stand BA 1.060

Fibreglass tripod with double clamp and screw.

PYTHAGORAS

Pythagoras BVBA was founded in January 2011, with developing and selling Pythagoras software as its main business activity. Although Pythagoras is a young company, its software is not. Pythagoras has already been serving professionals around the world for more than 20 years. Thanks to the company's close relationships with its clients, universities, partners and resellers, it knows what goes on in the geo market and hence can maintain its high level of innovation. Pythagoras is state-of-the-art CAD and GIS software for land management, road design, civil engineering and land surveying. It is one of the most powerful and intuitive CAD and GIS applications ever designed. Powerful tools allow users to quickly design projects in a user-friendly way.

www.pythagoras.net

Stand no. D3.043**RACURS**

As the result of more than 20 years' experience implementing the wishes of users from all over the world, PHOTOMOD 6.0 is now available. This powerful 64-bit version delivers a unique dense DSM creation algorithm, PHOTOMOD UAS module, significant displaying acceleration and multiple speeding up of block adjustment calculations. Intergo attendees are cordially invited to visit the stand and obtain information on new and further developments of the product programme.

www.racurs.ru

Stand A.1046

PHOTOMOD dense DSM.

RIEGL

At Intergo, RIEGL Laser Measurement Systems will present the first integration examples of the VUX-1 airborne Lidar sensor integrated for UAS applications as well as the new RIEGL VZ-2000 very long-range, high-speed 3D terrestrial laser scanner which provides an effective measurement rate of up to 400,000 meas./sec. The VZ-2000 is ideal for both stand-alone static and mobile laser scanning when combined with the new RIEGL VMZ hybrid mobile laser mapping system. Exciting software news too: RiSCAN PRO's new 64-bit version is more powerful and now ready for ultra-high definition (UHD) displays and processing! The RIEGL booth will also have several other hardware and software product highlights on display.

www.riegl.com

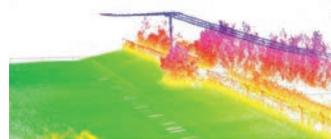
Stand no. A3.014

UAV helicopter equipped with the new RIEGL VUX-1 Lidar sensor.

ROUTESCENE

New to the market, the Routescene LidarPod is a complete turnkey system developed specifically for use on road vehicles and UAVs. Survey industry expertise is behind the Routescene LidarPod. The company understands the problems it customers need to solve and has combined intelligent thinking with experience to design a reliable, practical and cost-effective solution. As a result the Routescene LidarPod is a robustly engineered, self-contained system. It is simple to operate and enables rapid deployment in the field. The benefits are numerous, but most importantly it will save time, generating more detailed and faster results, and it will avoid exposure of personnel to awkward, dangerous and hostile environments.

www.routescene.com

Stand B4.007

Routescene LidarPod vehicle mapping a powerline.

RUIDE

Established in 1995, Ruide Surveying Instrument is an R&D and production-oriented enterprise focusing on surveying instruments. Aimed to meet wide range of precise and cost-effective requirements, Ruide offers a complete product line of GPS, total stations, theodolites, distance meters, digital levels, auto levels, accessories, etc. Ruide attaches great importance to consumer satisfaction. The company is establishing a wide sales and service network worldwide, devoting itself to providing the fastest and most professional sales service as well as technical support to various users in the world.

www.ruideinstrument.com

Stand no. C.4.014

RTS-862R Plus.

SANDING

With over 20 years' experience dedicated to R&D in precise surveying sector, Sanding has grown to be one of the significant suppliers of surveying instruments and solutions in the world. Today, the company has 5 production bases, specifying on R&D and production of full range of surveying equipment – GPS, total stations, theodolites, digital levels, distance meters, auto levels, laser levels, prisms and relevant accessories like tripods, staffs and poles. Ever since its establishment, Sanding has been insisting on 'precision + cost-effectiveness', aiming to enable its users to create maximum values with minimum investment.

www.sandinginstrument.com

Stand no. C.4.014

Sanding's T9.

SATEL

SATEL, a Finnish telecommunications company, specialises in the design and manufacturing of radio modems for wireless data communication. SATEL is introducing a 1W transceiver radio modem inside an IP67-classified housing: SATELLINE-Compact Pro. SATELLINE-Compact Pro is equipped with a rechargeable battery; it is at the same time a weather-proof housing and provides the required operating voltage for the radio modem. SATELLINE-Compact Pro has a wide 70MHz tuning range (403-473MHz) and the channel spacing is software-selectable too. All in the same package: powerful radio modem, weather-proof housing and battery. It is compatible with other well-known SATEL products plus other manufacturers' protocols.

www.satel.com

Stand no. E2.001

K96-T The third generation of **KOLIDA GNSS** receiver
With an extreme ability to track satellite signals, and superior speed to analyze the data, K96-T is going to be the king of the GNSS jungle.



● All-frequency Signal Capturing Technology

With upgraded all-frequency Antenna, K96-T well supports satellite signals from GPS+ GLONASS+COMPASS. After Galileo Positioning System completely comes to use in the future, K96-T need no modification in hardware, but only some upgrade in firmware to trace and analyze its signals.

● World Class GNSS Motherboard

220 channels, most advanced processing technology. 3mm+0.5mm RMS precision for horizontal measurement (static), 8mm+1ppm RMS precision for horizontal measurement (RTK).

● Flexible Working Mode

Built-in transceiving radio (emitting range 1-5km), compatible with all brands receiver; Seamless access to all brands CORS system; Workable under 2.5G/ 3G/ 3.5G mobile network.

● Optimized Design

With optimized design for hardware as well as firmware, K96-T provides higher work efficiency. Enhanced industrial level of waterproof, dustproof and shockproof ability (IP67) guarantees it to survive 1m-deep water long time immersion, and 2.5m natural drops.



KOLIDA
KOLIDA INSTRUMENT

KOLIDA INSTRUMENT CO., LTD.

Add: 2/F, Surveying & Mapping Building (He Tian Building), NO.24-26, Ke Yun Road, Guangzhou 510665, China

Tel: +86-20-85542075 Fax: +86-20-85542136

E-mail: export@kolidainstrument.com

<http://www.kolidainstrument.com>



SATELLINE-Compact Pro.

SATLAB

Machine Control Sensor ML300 is a rugged GNSS sensor intended for the machine control market. The magnesium alloy housing and its special inner structure provides an extensive endurance for the extremely harsh environment of heavy construction machinery. The company has recently founded SatLab Inc. in Phoenix, AZ, USA, to expand its business into North America. The concept of SatLab, with locally tailored solutions, has been highly appreciated within the distribution network and resulted in increased yearly sales. In order to expand this success and appreciation, the company has opened its new facility to better serve North American customers.

www.satlabgps.com

Stand no. B4.032



New-generation SL600.

SBG SYSTEMS

With the very-low-noise gyroscopes and high output rate, the new miniature Ellipse sensors are especially effective when mounted on a UAV for data georeferencing and onboard instrument orientation or stabilisation. On the ground, Ellipse sensors connect to an odometer while receiving RTK corrections for an accurate trajectory, even during GPS outages. With the Ellipse Series, SBG Systems is setting a new standard for miniature inertial systems. It provides up to 0.20° roll, pitch and heading, and reaches centimetre-level accuracy when receiving DGPS corrections.

www.sbg-systems.com

Stand no. C1.059



Ellipse sensor.

SCALYPSO

The latest Scalypso product is the new developed Scalypso City tool. Scalypso City allows visualisation of 'unlimited' point cloud data in real time. It does not matter if the data is generated with a terrestrial, mobile or Lidar laser scanning system – every kind of laser-scanned data can be processed immediately. Users can measure, fly and walk through their coloured scan projects. Scalypso City is able to display whole cities, large buildings or complete plant sites in real time. The other Scalypso products are: the Modeler, the Viewer, and the Navigator.

www.scalypso.com

Stand no. A1.036



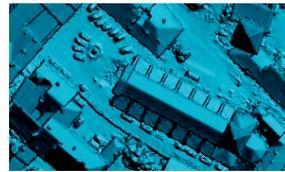
A street visualised with Scalypso City.

SIMACTIVE

SimActive is the developer of Correlator3D software, a patented end-to-end photogrammetry solution for the generation of high-quality geospatial data from satellite and aerial imagery, including UAVs. Correlator3D performs aerial triangulation (AT) and produces dense digital surface models (DSM), digital terrain models (DTM), orthomosaics and vectorised 3D features. Powered by GPU technology and multi-core CPUs, Correlator3D ensures matchless processing speed to support rapid production of large datasets. SimActive has been selling Correlator3D to leading mapping firms and government organisations around the world, offering cutting-edge photogrammetry software backed by exceptional customer support.

www.simactive.com

Stand no. B2.063



Correlator3D.

SITECO

Siteco is a highly specialised software house focused on road information systems and mobile mapping systems, with a consolidated international reputation. The development of Road-Scanner mobile mapping system started in 2010 and today it's used worldwide to produce high-grade mapping, asset management and pavement management system databases. Among the most advanced projects: high-grade mapping assuring 15-20mm of accuracy. The Road-SIT road information system and the PMS for roads and airports make Siteco's offer a complete solution: survey, inspection, asset database and pavement management, and maintenance. Siteco will be showing its new solution at Intergo.

<http://www.sitecoinf.it>

Stand no. C3.009



Road-Scanner.

SITEPRO

Dave White's SitePro is committed to offering quality accessory products for surveying and construction instruments. SitePro offers a diverse range of products, all manufactured and marketed to provide the highest quality at the most competitive prices. SitePro products are sold through a network of dealers and distributors. At Intergo 2014 the company will be showcasing its newest products: the SLR 300H horizontal self-levelling rotary laser for precise outdoor levelling applications, the SKT 05 5-second theodolite with superior optics, and the SiteMax HVFG composite tripod with dual clamp, the best-value tripod on the market.

www.sitepro.us.com

Stand no. B1.060



SitePro's newest products.

SMARTPLANES

SmartPlanes provides a complete and flexible UAS system with everything needed for smart working. The SmartPlanes aerial survey system is delivered together with all the hardware and software necessary for performing successful missions day after day, year after year. The large and flexible cargo bay will make upgrades of the sensors possible depending upon each customer's needs. The system is easy to transport for one person; no catapults or suchlike are needed. The system has been developed in close co-operation with users from many different fields: survey, forestry, agriculture and many more. This has made it possible to streamline the system for professional use.

www.smartplanes.se

Stand no. D3.016



SmartOne unmanned aircraft.

SOFTWARE-SERVICE JOHN

Software-Service John will showcase a new technical solution of railway planning in VIS-All 3D at Intergo. To make the planning of railway tracks more simple and efficient, the module '3D-Trassenentwurf-Schiene' was developed. VIS-All 3D combines planning, control, visualisation and cost estimation. Based on the DTM, orthophotos and other information about the area, users are able to find and optimise different railway tracks according to the guidelines directly in the 3D surroundings. Furthermore, important buildings such as bridges, tunnels, turnouts and platforms can be defined and added to the project in order to keep sight of all costs.

www.john-software.de

Stand no. E2.039

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- They are fully customizable to suit any situation.



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Kuipershaven 22, 3311 AL Dordrecht, The Netherlands



Railway planning in a new way.

SOMAG

SOMAG, headquartered in Jena (Germany), designs, manufactures and sells gyro stabilisation devices which carry airborne sensors and cameras for aerial photography or geospatial data acquisition. At Intergo, the company is introducing the GSM 4000, which is its latest device and the successor of the globally renowned GSM 3000. Intergo attendees are welcome to visit the stand to see the benefits and advantages of the company's devices for themselves.

www.somag-ag.de
Stand no. A3.004



GSM 4000.

SOUTH

As the flagship enterprise in China's surveying industry, SOUTH never made a pause in enhancing its brand construction. This year, which marks SOUTH's 12th year of participation at Intergo, the latest products and technologies will be presented along with some classics. Included at the event will be 1000 reflectorless total station 370R10, NTS-380R10 and 800 reflectorless total station NTS-341R8A, auto level DSZ series, digital level DL series, handheld distance meter PD series, and rotary laser TRL series. Upgrading version CORS receiver S9 and new RTK S650, S82-2013, S86-2013 will also be on display. Intergo visitors are welcome to visit the stand.

www.southinstrument.com
Stand no. C.4.014



370R total station.

SPECIM

SPECIM is presenting its renewed portfolio of the AISA airborne hyperspectral sensors. Together with its partners, SPECIM provides solutions that cut the costs of aerial survey data collection and additionally those of data classification. The AISA spectrum imagers are optimal for applications such as geological mapping, agricultural monitoring and optimisation, environmental damage assessment, forestry surveys, vegetation monitoring, water-quality assessment, and detection of materials in industrial processes. SPECIM is also showcasing, together with Diamond Aircraft and SOMAG, the powerful hyperspectral multi-sensor aircraft, the turnkey solution for aerial surveying.

www.specim.fi

Stand no. A3.004



SPECIM's AISA spectrum imagers for all applications.

SPECTRA PRECISION

Spectra Precision has long been an established brand, known for delivering quality products to the construction market. Focusing on the specific needs of the conventional surveying market, the Spectra Precision brand offers a complete product portfolio including: global navigation satellite systems (GNSS), global positioning systems (GPS), mechanical and motorised optical total stations, data collection hardware, field and office software, GIS solutions as well as a wide range of construction tools. Spectra Precision surveying equipment is an economical choice that utilises technologies for optimal efficiency. With convenience and reliability as the foundation of the Spectra Precision brand, it is an ideal choice for value.

www.spectraprecision.com

Stand no. C2.016



Spectra Precision SP80.

STESALIT

Stesalit has announced the availability of the SXtreo range of rugged GPS handhelds as part of its enterprise mobility practice, for field work under extreme conditions, industrial use, and infrastructure sectors including agriculture, forestry, roads, security and construction. The SXtreo GN series of rugged GNSS field computers comes with a full keypad and large, 5-inch sunlight-readable screen designed for GPS data acquisition and asset management. The devices are ideal for socio-economic surveys, mapping, agriculture, logistics, forestry, public transportation, construction and security.

www.stesalitsystems.com

Stand no. D3.029



SXtreo rugged GNSS field computer.

SUPERGEO

Supergeo is a global leading GIS software provider, serving users from over 100 countries in the world. The comprehensive SuperGIS series of products can meet every GIS professional's demand. Desktop GIS provides powerful mapping performance and various analyst extensions to support effective decision-making. Server GIS offers easier GIS data managing and publishing to enhance web service. Mobile GIS provides practical data capture functions for various platforms to simplify field operation. 3D GIS facilitates intuitive interaction with innovative 3D maps to better understand the world.

www.supergeotek.com

Stand no. A3.033



SuperSurv.

TALLYSMAN

Tallysman's mission is to provide GNSS

antennas which meet the needs of a new generation of positioning systems, providing unprecedented accuracy at ever-decreasing prices.

Tallysman will be introducing a new product (TW5430) and a new patented GNSS antenna technology at Intergo. The TW5430 is a multi-constellation receiver/antenna employing Tallysman's unique Accutenna technology. The TW6000 will be introduced as the first antenna with revolutionary patented technology which provides a phase centre variation of less than 1mm across all GNSS frequencies and extremely low axial ratios from horizon to horizon.

www.tallysman.com

Stand no. D4.008



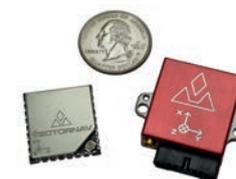
TW5430.

VECTORNAV

VectorNav Technologies specialises in manufacturing high-performance navigation and inertial sensors using the latest miniature MEMS sensor and GPS technology. With a strong background in aerospace engineering and experience in the development and testing of spacecraft, launch vehicles and MAVs, VectorNav brings high-performance aerospace filtering and calibration techniques into the world of geodesy, geoinformation and land management, expanding the possibilities for high-performance navigation, stabilisation and correction for applications in these fields. At Intergo 2014, VectorNav will have on display its newly released VN-300 dual antenna GPS-aided inertial navigation system, as well as its industry-leading VN-200 GPS/INS and VN-100 IMU/AHRS.

www.vectornav.com

Stand no. D3.003



VN-200 GPS-aided inertial navigation system.

► **OCTOBER**

SYMPOSIUM ON SERVICE-ORIENTED MAPPING 2014

Potsdam, Germany
from 06-08 October
For more information:
W: <http://somap.cartography.at>

INTERGEO 2014

Berlin, Germany
from 07-09 October
For more information:
E: dkatzer@hinte-messe.de
W: www.intergeo.de

UAV SHOW EUROPE

Merignac, France
from 07-09 October
For more information:
W: www.uavshow-europe.com

GEOFORM+

Moscow, Russia
from 14-16 October
For more information:
E: ledenyova@ite-expo.ru
W: www.geoexpo.ru

14TH INT'L SCIENTIFIC AND TECHNICAL CONFERENCE "FROM IMAGERY TO MAP: DIGITAL PHOTOGRAMMETRIC TECHNOLOGIES"

Hainan, China
from 20-23 October
For more information:
E: conference@racurs.ru
W: <http://conf.racurs.ru/conf2014/eng>

THE COMMERCIAL UAV SHOW

London, UK
from 21-22 October
For more information:
E: matthew.pullan@terrapinn.com
W: www.terrapinn.com/exhibition/commercial-uav/index.stm

HEXAGON GEOSPATIAL BENELUX 2014

Capelle a/d IJssel, The Netherlands
on 30 October
For more information:
E: info@imagem.nl

AARSE 2014

Cape Town, South Africa
on 27-31 October
For more information:
W: <http://africanremotesensing.org>



FIG COMMISSION 7 ANNUAL MEETING AND GEOCONFERENCE 2014

Quebec, Canada
from 07-11 October
For more information:
W: www.fig.net

► **NOVEMBER**

GEODATA 2014

Glasgow, Scotland
on 04 November
For more information:
E: geodata@geoaware.info
W: www.geoaware.info

UNMANNED SYSTEMS CANADA ANNUAL CONFERENCE 2014

Montreal, QC, Canada
from 04-07 November
For more information:
W: www.unmannedsystems.ca



4TH INTERNATIONAL FIG 3D CADASTRE WORKSHOP

Dubai, United Arab Emirates
from 09-11 November
For more information:
E: p.j.m.vanoosterom@tudelft.nl
W: www.gdmc.nl/3dcadastres/workshop2014/

14TH ANNUAL UNMANNED AERIAL SYSTEMS 2014

London, UK
from 17-18 November
For more information:
W: www.uasconference.com

PECORA 19 & ISPRS COMMISSION I SYMPOSIUM

Denver, CO, USA
from 17-20 November
For more information:
W: www.asprs.org

PACIFIC GIS/RS USER CONFERENCE

Suva, Fiji Islands
from 25-27 November
For more information:
W: www.fig.net

11TH INTERNATIONAL SYMPOSIUM ON LOCATION-BASED SERVICES (LBS2014)

Vienna, Austria
from 26-28 November
For more information:
W: www.lbs2014.org

► **DECEMBER**

SPAR EUROPE/ELMF

Amsterdam, The Netherlands
from 08-10 December
For more information:
E: lcorkhill@divcom.com
W: www.sparpointgroup.com/europe/

CALENDAR NOTICES

Please send notices at least 3 months before the event date to: Trea Fledderus, marketing assistant, email: trea.fledderus@geomares.nl

For extended information on the shows mentioned on this page, see our website: www.gim-international.com.

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