GIM INTERNATIONAL

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Robots in Surveillance

Safe Navigation for Autonomous Robot Systems

Dense Image Matching

Performance Analysis on Oblique Imagery

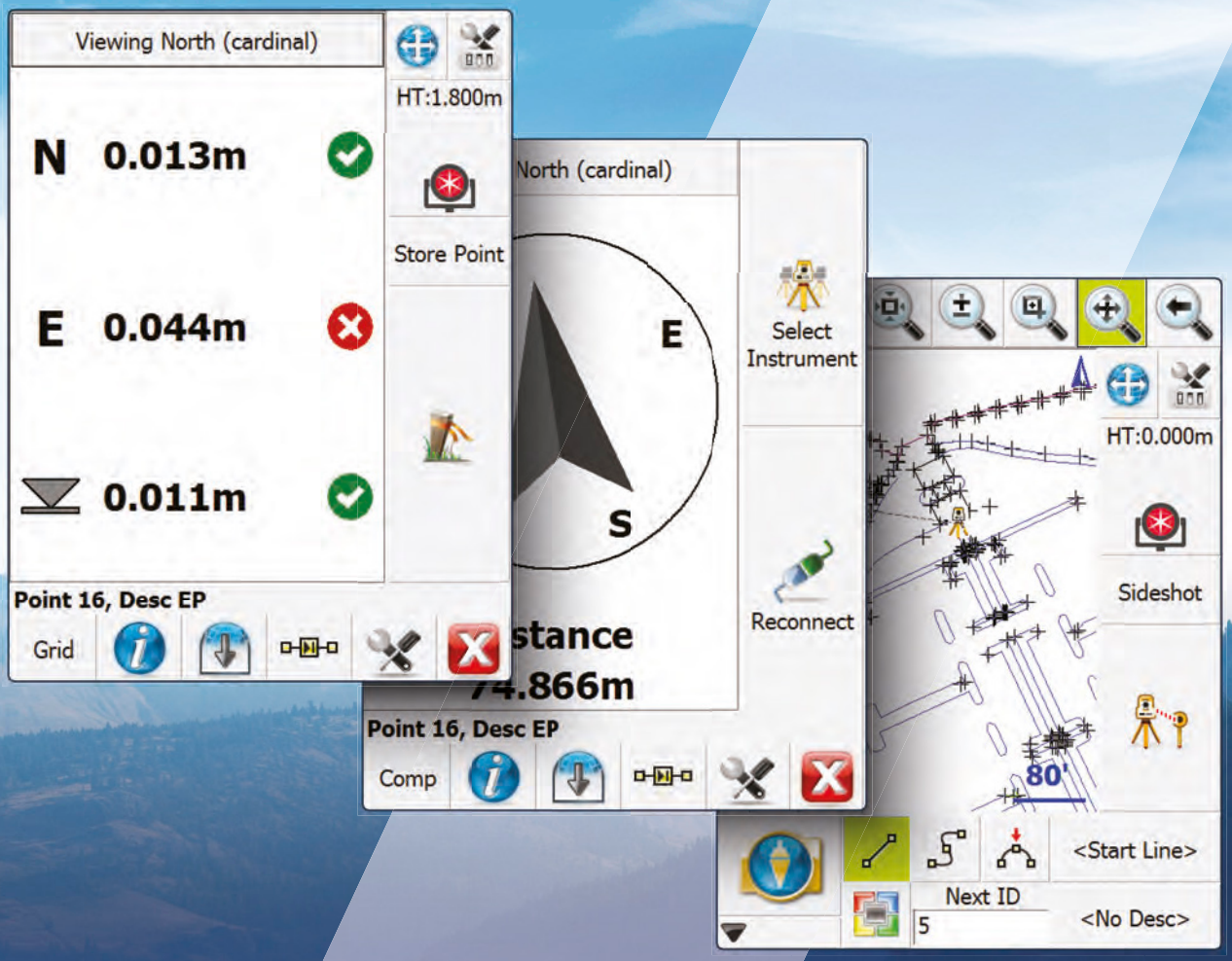
Automated Map Generalisation

Meeting Today's Information Demands

GIM International Interviews

Andre Nonguierma

EXPERIENCE FieldGenius 7



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BPA WORLDWIDE BUSINESS

Ambassadorial Role

During the Fourth Session of the United Nations Global Geospatial Information Management (UN-GGIM) Committee of Experts, held in August 2014 in New York, USA, the geospatial world furthered the extent to which it is embedded in the governmental and policymaking environments of the United Nations Member States. Delegates from all over the world debated a resolution on a Global Geodetic Reference Frame for Sustainable Developments and endorsed it for further referral to the General Assembly. The Committee of Experts talked about the development of a knowledge base for geospatial information and it received updates on the work of regional GGIM initiatives, amongst others in the Americas, the Middle East and Asia Pacific, and heard about the start of such regional initiatives in Africa and Europe. Furthermore, it endorsed the International Year of the Map 2015-2016 and discussed standards and many other topics. Despite the full programme, coffee breaks and lunch offered ample time for delegates to talk in the corridors of the conference building, exchanging information and best practices, meeting old friends and making new acquaintances. Through this effective and efficient meeting in New York, the UN-GGIM Committee of Experts proved it could coordinate its own agenda and was able to cut out redundancies in work already being done by other bodies in the field. In that sense, the Committee established itself as a justified body at global level. Many professionals in this field probably still feel left in the dark about what the UN-GGIM Committee of Experts is doing in New York, but having witnessed the activities for a few days as an observer, it is clear to me that the UN-GGIM – and its regional initiatives – could play a leading role in promoting the further deployment of geoinformation as ambassadors within their governments. There are of course already a lot of governments who see the benefit of the use of geoinformation in policy- and decision-making, but there are also still many who don't – sometimes because they are just not aware, and sometimes because they simply lack funds. Having the United Nations act as the ambassador can and will open doors that have remained closed so far, in terms of both awareness and money. That ambassadorial and steering role of the experts within their own governments can have a very positive effect that will trickle down to the societies they govern. Policymakers on all levels will need geoinformation; decisions will no longer be made without a geospatial foundation, and the geospatial industry will gain massive benefits from this initiative, which is played out in that faraway United Nations building on the East River in New York City.

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Photography: Arie Bruinsma

P.S. In the next issue of *GIM International* you will be able to read more about the outcomes of the Fourth Session of the UN-GGIM Committee of Experts

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No 2623

The front cover of this edition of *GIM International* shows a UGS and a UAS in tandem during a surveillance operation. This issue includes an article on the German SiNafaR project: Robots in Surveillance (page 33 onwards).

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GIM International, the global magazine for geomatics, is published each month by Geomares Publishing. The magazine and related e-newsletter provide topical overviews and accurately presents the latest news in geomatics, all around the world. *GIM International* is orientated towards a professional and managerial readership, those leading decision making, and has a worldwide circulation.

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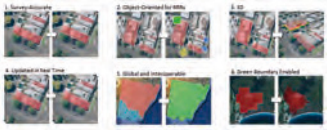

Successful FIG Congress

It was a privilege to attend the FIG Congress in Kuala Lumpur, Malaysia, in June this year and to witness the success – not only of the Congress management overall, but also of the advances in policy development and exposure of the profession in the international sphere. The opening session was an impressive event, attended by the Prime Minister of Malaysia, the Honourable Dato' Sri Mohd Najib bin Tun Abdul Razak. The Association of Authorized Surveyors Malaysia (PEJUTA) did an outstanding job in convincing the Prime Minister to open the Congress. In his speech (which is also available on YouTube) he stressed the importance of spatial information for sustainable development in Malaysia. Prior to his presentation, the president of FIG, CheeHai Teo, spoke well of the significance of the work being undertaken by FIG with respect to sustainable development, and the overall importance of the work of the surveying profession and its contribution to society.

PROF JOHN C TRINDER
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This year, the Young Surveyors Network sessions were held for the first time at a FIG Congress. The plenary sessions covered details of challenges to the profession brought about by undernourishment, climate change and economic progress; the key roles that the profession can play in the betterment of society and the environment; and actions that need to be taken to achieve the targets set in the Post-2015 Development Agenda towards 'Realizing the Future We Want for All'. Some plenary speakers said that they had never seen an FIG Congress looking so interesting.

The FIG publication *Fit-for-purpose Land Administration* has gained considerable recognition by organisations such as the World Bank and was discussed in detail at the Congress. A fit-for-purpose system should be flexible, affordable, reliable, attainable, upgradable, a continuum of accuracy and inclusive. Land administration systems developed by Western nations, which took hundreds of years to achieve into their current form, are not necessarily transferable to developing countries such as in Africa or central Asia. Sessions were held describing approaches taken by various countries to develop their land administration systems to satisfy the needs of their people while ensuring that they remain financially viable. One important development for the profession is the proposed resolution to be presented to the UN General Assembly later this year for approval on the development of an operational global geodetic reference frame (GGRF) – infrastructure that will support the increasing demand for positioning and monitoring applications which will have significant societal and economic benefits. This is said to be the first time that a geospatial information resolution has been brought to a General Assembly of the UN, and credit is due to the UN-GGIM (Global Geospatial Information Management) for achieving this recognition.

The topics discussed at the 15 parallel technical and special sessions were very diverse and they provided something of interest for all participants. Overall, the Congress was a great success in terms of organisation and its impact on policy development, and the Malaysians deserve hearty congratulations for staging such a successful event.

COWI HELPS BORDER DRAWING BETWEEN MALAWI AND MOZAMBIQUE ++ INTEGRATED WORKFLOW FOR ROAD AND SITE CONSTRUCTION ++ ICC 2015: CALL FOR ABSTRACTS ++ ESRI HONOU
APPROVED ++ ALTUS LAUNCHES RTK RECEIVER FOR ESRI COMMUNITY ++ ACUTE3D LAUNCHES SMART3DCAPTURE EDITION FOR UAS OPERATORS ++ 12TH ISPRS STUDENT CONSORTIUM TO

COWI Helps Border Drawing between Malawi and Mozambique

COWI has won the assignment to map the watershed line between the two African countries Malawi and Mozambique in an international tender by German Development Cooperation GIZ. The project supports the African Union's border programme in its endeavour to demarcate all African borders by 2017.

http://bit.ly/1lGtMT5

Orthophoto overlaid with contour lines.

UNSD Appointment of Stefan Schweinfest Formally Approved

Ban-ki Moon, the secretary-general of the United Nations, has formally approved the appointment of Stefan Schweinfest as director of the United Nations Statistics Division (UNSD) and thus as the secretariat of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM).

http://bit.ly/1lGwEPW

Stefan Schweinfest.

Smart3DCapture Edition for UAS Operators

Acute3D, a leader in automatic 3D reconstruction from photographs, has announced a new edition of its Smart3DCapture software called Smart3DCapture Advanced. In response to many requests, and in order to offer Smart3DCapture technology to a wider audience, Smart3DCapture Advanced has been created to be best suited for – but not limited to – UAS operators and land surveyors.

http://bit.ly/1lGxagN

Smart3DCapture viewer.

RS ROYAL DUTCH SHELL WITH ENTERPRISE GIS AWARD ++ UNSD APPOINTMENT OF STEFAN SC LY
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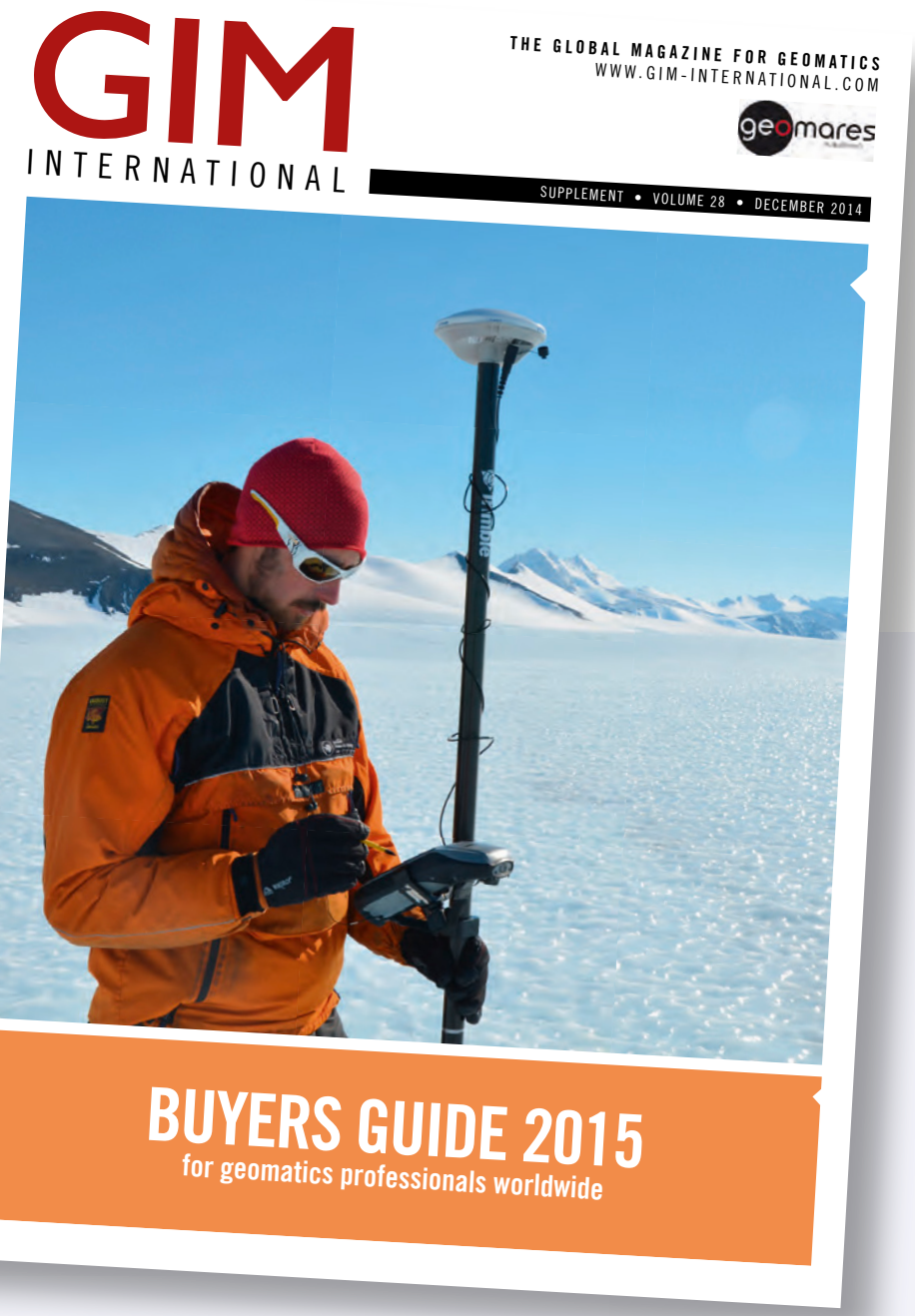

The most extensive source for professionals working in geomatics is currently prepared. Readers will find this year's Buyers Guide on their desks together with December issue of GIM International. Did you know that the Buyers Guide is distributed at tradeshows all over the world during the year and that the online version of the Buyers Guide on the website of GIM is one of the most popular places to look for partners in business? Just now, you shouldn't be missing out on this opportunity for extra business!

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ICC 2015: Call for Abstracts

The 27th International Cartographic Conference will be held in Rio de Janeiro, Brazil, from 23 to 28 August 2015. This conference is taking place for the first time in Brazil and for only the second time in South America. A call for abstracts has now been issued by the organisation.

http://bit.ly/1lGuvUn

ICC 2015, Brazil.

Altus Launches RTK Receiver for Esri Community

At the 2014 Esri User Conference, Altus Positioning Systems unveiled a totally new GNSS RTK receiver designed and developed specifically for the Esri user community. According to Altus CEO Neil Vancans, the new Altus APS-NR2 provides a combination of performance and features that make it ideal for Esri users.

http://bit.ly/1lGwYOs

5 QUESTIONS TO...

Olaf Freier

Olaf Freier, managing director of Hinte, the organiser of Intergeo.

Intergeo celebrates its 20th anniversary this year. How have things changed over the years?

Over the past 20 years, Intergeo has created a platform for exchange and facilitated dialogue. In the beginning there was an explicit focus on geodesy, but new topics relating more broadly to geoinformation and land management have gradually emerged. A growing number of technologies and sectors have a geographical connection because everyone is interested in location. It's no longer just about the product; customers don't want one-off technologies, but are instead looking for solutions for entire process chains. And, now more than ever, manufacturers are able to offer such end-to-end systems.

Can you still remember the first event?

Absolutely. It took place in Dortmund and I was exhibiting for a company called Geo++. The hot topics then were GPS and navigation. The trade fair was shaped by satellite technologies, which had revolutionised measuring processes. However, the second Intergeo was more significant for me personally since that was where I met my future wife. She was an Intergeo project manager but I apparently lured her away from the job later. [Laughs]

What has made the Intergeo such an international success?

The combination of trade fair and conference has certainly played a part in its rapid success and ability to fully address the topic areas at international level. Notably, back in 1995 only around 15 percent of exhibitors came from outside Germany, whereas nowadays that figure is over 40 percent. Overall, the number of exhibitors has almost trebled from 180 to more than 500. In the early days, just ten percent of visitors came from abroad whereas international visitors now account for around a third of attendees. This means we can rightly claim to be the world's largest trade fair in our industry. We bring together experts and market leaders from all over the world.

Considering the wide variety of topics on offer during the event, how can visitors hone in on what interests them?

The sheer size of the programme has led us to develop a diverse range of tools and communication methods. Our recently relaunched website is obviously the first port of call for visitors and they can easily select their preferred topics there. Professionals can also consult the Intergeo app for information on the go. This enables visitors to explore and select from the broad programme in a way that suits them. The app is also the best way of navigating both the trade fair and the conference during Intergeo itself.

What are your hopes for the anniversary event? What are the highlights?

Naturally, I'm hoping for a successful Intergeo for exhibitors and visitors alike. For this anniversary year, one of the most vibrant cities in the world awaits them! Berlin has lots to offer, not just as a trade fair venue but also in terms of culture and history, and choosing Berlin has enabled us to address aspects of German national politics. We will be welcoming two German Federal Ministers: Federal Minister of the Interior Dr Thomas de Maizière and Federal Environment Minister Dr Barbara Hendricks. This is real recognition for the industry. In addition, the European umbrella organisation EUROGI is hosting its 2nd 'imaGIne' Conference at Intergeo. That is a real vote of confidence for us and a genuine programme highlight for visitors. Last but not least: we will also be honouring around 35 companies that have been with us since the very start of Intergeo!

MORE INFORMATION

www.intergeo.de

Promote Your Company in the Intergeo Preview

As the loyal readers of GIM International have come to expect, we will once again be publishing a bumper-packed October issue dedicated to Intergeo. If you would like your company to be included in our Intergeo Preview, please send me your input (100-word text describing your company and what Intergeo visitors can expect to see at your stand, plus a relevant image [N.B. no logos please!]) at wim.van.wegen@geomares.nl.

You can also send me an e-mail to arrange a meeting during Intergeo to discuss editorial opportunities in GIM International. If you would like to explore advertising possibilities with our account manager Sybout Wijma, please contact him at sybout.wijma@geomares.nl.

Wim van Wegen, editorial manager

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No 2622

Getmapping Acquires Promap Civil Engineering

As part of its continued expansion into Africa, Getmapping has acquired Promap Civil Engineering Surveys, based in Pretoria, South Africa. Promap is a leading supplier of aerial and ground survey services across southern Africa. The acquisition complements Getmapping's existing wholly owned African subsidiary, Geosense, by increasing the aerial Lidar survey capacity within the group. The acquisition of Promap also adds a fixed-wing survey aircraft plus large-format Lidar and an established ground survey team to the group's capabilities. ◂

▸ **http://bit.ly/1lGzBjl**

Geosense and Promap representatives.

Joint EuroSDR and ISPRS Workshop

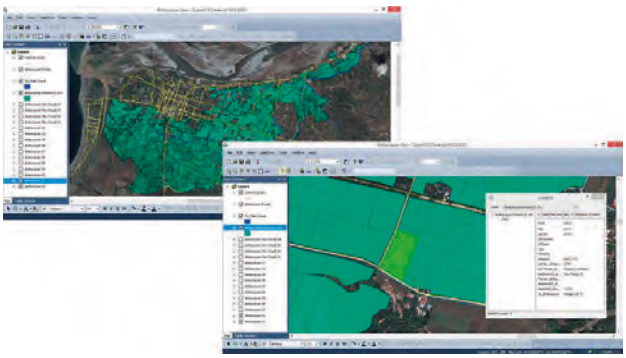
EuroSDR and ISPRS have announced a joint workshop, titled 'Efficient Capturing of 3D Objects at a National Level: with a Focus on Buildings and Infrastructure'. The event will take place from 26-28 November 2014 at Ordnance Survey in Southampton, UK. Professionals are invited to give a presentation or demonstration on one of the above-mentioned topics. To apply to participate, a 300-500 word abstract can be sent to j.e.stoter@tudelft.nl. Closing date is 30 September 2014. ◂

▸ **http://bit.ly/1lGA70H**

NIA Upgrades Parcel Maps in Philippines

The Philippines National Irrigation Systems (NIA) is teaming up with Supergeo Technologies to upgrade the country's parcellary maps through SuperGIS Desktop to elevate the efficiency of irrigation planning and billing for agricultural development. With the assistance of RASA Surveying, Supergeo partner in the Philippines, National Irrigation Systems (NIA) is utilising SuperGIS Desktop 3.2 to upgrade parcellary maps of 10 selected irrigation systems nationwide to clarify and correct landholding sizes and owners' listings. ◂

▸ **http://bit.ly/1lGAnNr**



SuperGIS Desktop 3.2.

12th ISPRS Student Consortium to Follow ACRS 2014

Following the tradition of previous Asian Conferences on Remote Sensing (ACRS) held since 2010, an international student summer school will be organised after the ACRS 2014, which will take place at Nay Pyi Taw, Myanmar, from 1-5 November 2014. This will be the 12th ISPRS Student Consortium and WG VI/5 Summer School, co-organised by the ACRS 2014 and the Asian Association on Remote Sensing (AARS). ◂

▸ **http://bit.ly/1lGxj3S**

Topcon Announces MS AXII Measuring Station

Topcon Positioning Group has released the latest edition to the MS line of high-precision total stations in the North and South American markets. The MS AXII measuring station series is designed for precision-intensive tasks such as monitoring, bridge construction and other highly detailed engineering projects. ◂

▸ **http://bit.ly/1lGzNz0**

Topcon MS AXII total station.

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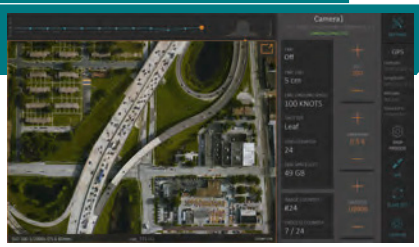


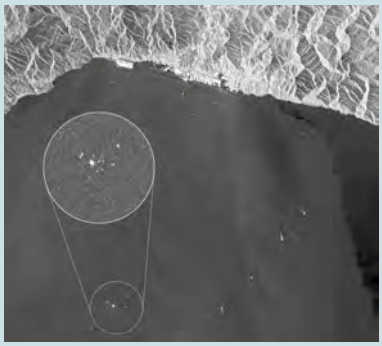
iX Capture application.

Application Enables Streamlined Aerial Data Capture

Phase One Industrial has released the iX Capture application. Specifically designed for use with Phase One aerial cameras, the iX Capture application was built from the ground up for in-flight capture and RAW conversion. All essential camera functions can be controlled using a computer equipped with a touchscreen or mouse. ◂ ▸ **http://bit.ly/1lGxtIr**

Satellite Images of Towing of Costa Concordia

The Sentinel-1A satellite captured images of the Costa Concordia on 26 July 2014 off the coast of northwestern Italy as the vessel was being towed towards the city of Genoa. The ship capsized near the island of Giglio in January 2012. Following more than two years of salvage operations, the ship began its final journey under tow on 23 July 2014, arriving at the port of Genoa four days later. ◂ ▸ **http://bit.ly/1lGAUih**



Towing the Costa Concordia (Courtesy: ESA).

Open Data and Quality

For decades, quality as an essential dimension in using geodata has been neglected by many GIS users. As a result of open data and the tendency to combine geodata from a wide diversity of sources, one now faces the dilemma of discrepancies arising between one dataset and another. In the meantime, many people have burned their fingers and suddenly there it is: after decades of disregard, the quality issue is now appearing high on the agenda of GIS users. Few of them grasp that the subject is not only key, but also complex. To illustrate the scale of the quality challenge, I will focus here on a rather technical topic: measures of precision, in particular CE90, RMSE and σ. I appreciate that these may be unfamiliar terms to many people. CE90 stands for 'circular error at 90% confidence'. This accuracy standard, developed during WWII by the USA, is a convenient single measure for describing the accuracy of an (ortho)image or a map. It is expressed as the horizontal distance that any point in the image will differ from its actual position on the ground for 90% of the time. To calculate the distance, a set of ground control points (GCPs) is used. The coordinates of the GCPs in the image are measured and subtracted from the actual values as measured in the terrain by an accurate device, e.g. a high-definition GNSS receiver. Graphically this may be interpreted as the radius of a circle, which contains 90% of the residuals (red circle in Figure). Root mean square error (RMSE) and standard deviation (σ), which are other measures of precision, are directly related to CE90. The planar or circular RMSE, obtained by combining the RMSE along the X axis and the RMSE along the Y axis using the Pythagorean theorem, is 0.466 x CE90 (yellow circle in Figure). If positional precision is given as σ, which is usually derived from an RMSE computation and set equal to the RMSE, CE90 and σ can be easily converted. As a rule of thumb, σ gives a two times better impression of precision than CE90. Whatever measure of precision is used, if positional precision is key for the task at hand it is wise to validate the communicated values by measuring accurate GCPs, well distributed over the scene, oneself. This is also to identify possible space dependency of the error distribution which can be analysed and visualised by drawing vector plots.

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GIM INTERNATIONAL INTERVIEWS ANDRE NONGUIERMA

UN Stimulates African SDIs

In Addis Ababa, Ethiopia, the United Nations Economic Commission for Africa has a Geoinformation Support Team of a dozen people striving to develop spatial data infrastructures (SDIs) Africa-wide. "Progress on formal SDIs has been very slow, but the geospatial capacity is notably improving on the continent," concludes team member Andre Nonguierma.

What is the UN's role in the development of SDIs in Africa?
At the regional level, we emphasise the development of the African Regional Spatial Data Infrastructure. We raise awareness among stakeholders and facilitate the formulation of policies and strategies to put in place co-ordination mechanisms, common frameworks, tools and suchlike. At the national level, we help to instate policy dialogue and institutional arrangements for co-operative production, management, dissemination and use of geoinformation resources. In general, there are three main stages of development for a national SDI. In the first stage, stakeholders work out the policies and institutional agreements through a participatory process and consensus building. Secondly, during the implementation stage, stakeholders collaborate on standards and interoperability for common base themes, geodetic reference, metadata production, dataset building, capacity development, etc. The third phase concerns monitoring and adjusting the whole process. Our advisory services concentrate on the early stages, as was done for several countries such as Ivory Coast, Nigeria, Burkina Faso and Sierra Leone. The first phase is the most critical, since policy development is always a highly sensitive issue because it involves people: end users and decision-/policymakers, their influence and their privileges.

What is the most prominent stage?
Around 50% of the 54 African countries have formally taken steps to develop their national geoinformation policies. However, besides Nigeria and South Africa, the initiatives in many countries were stalled after setting up the management committee. Although we must acknowledge that the overall progress in developing integral, structured SDIs has been very slow, mainly due to poor awareness, we can equally recognise that the geospatial capacity on the continent is notably improving. Many countries participate in a variety of geospatial science and technology initiatives. A number of nations have established remote sensing centres and/or mapping agencies. Many universities are offering remote sensing programmes. Algeria, Nigeria, Egypt and South Africa have acquired Earth observation satellites. Furthermore, individual citizens are becoming more involved by creating and distributing their own geospatial information, and the use of spatially enabled services is rising across the continent.

Ultimately, will the African SDIs differ much from the ones we see elsewhere?
Technically: no – we're catching up fairly quickly. For instance, the communication infrastructure is improving significantly. Although the electricity supply is still a challenge in many countries, we have more and more geospatial content in the cloud and therefore geospatial information and services are now broadly accessible. But on an institutional level: yes. Even when there is a good mass of infrastructure installed, the human capacity is still challenging. Firstly, many young Africans decide to study geoinformatics on other continents and end up staying abroad. Secondly, data sharing is very difficult in Africa because many decision-makers still think that sharing lessens their power. That stretches the agenda for building consensus and dialogue for data custodianship.

How do you cope with that resistance?
Our starting point is to ensure that the stakeholders see themselves and the others as an equally important part of the chain, and that the responsibilities are shared transparently. I know that the problem is not unique to the African continent, albeit that other continents face it to a lesser degree. For instance, a multidisciplinary study in Europe ('Spatialist' by the University of Leuven) has demonstrated that it could help to organise interest groups in 'vertical columns' around a chain of workflows in the same thematic area, crossing different policy levels and organisations. In Africa, that could work for focus groups on climate change, peace and security (border issues), trans-boundary transport modes, infrastructural development of cities, seismographic monitoring, water management and so on.

As with any strategy, if there is no professional group-based determination to implement it, no significant result will be achieved. Therefore it makes sense to start with a basic nucleus of key champions to craft the right set of integrated building blocks. Then, in the course of the process, it becomes achievable to incorporate more actors and evolve the SDI into an enabling platform that helps to link services across jurisdictions, organisations and disciplines. Obviously, a

Andre Nonguierma

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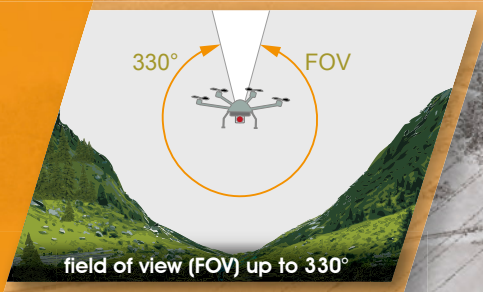

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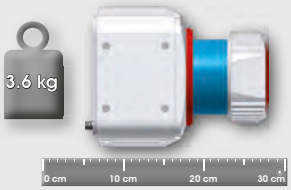

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governance and policy mechanism is necessary to guide the process from start to finish.

Suppose a miracle happens: the most prominent professional problem reaches an acceptable level. How will you know when that miracle has occurred?
In that case, we will see functional clearing-house systems. With metadata clearing houses in place, users can know what information resources are available and where, and can appraise them in relation to their own needs. To make this dream come true, more policymakers must perceive the link between geoinformation products and societal benefits. They must fully understand that most of today's issues have a significant spatial aspect. Therefore, we promote prototyping of customer-focused and locally centred services. We don't emphasise that they must first create an optimal dataset or data warehouse. Our motto is: start working with what you have.
A functional prototype can be taken to Parliament or a local council to enlighten them on the connection between GIS and national social and development issues. In Burkina Faso, for instance, a web service was developed in this way which is now used for many day-to-day decisions, including by companies and civilians, allowing them to see the relationships between mining mineral resources and impact on the landscape, economy, water resources and ecosystems. As a result, the application is becoming increasingly well known across the country and the underlying datasets are gradually improving.

Does such patience pay off in the field of mapping too?
Around 2.5% of the continent is mapped at 1:25,000 scale, and 15 countries currently have new mapping initiatives. That's why we initiated the Mapping Africa for Africa programme. One important component of that is the African Reference Frame Project (AFREF), which is aimed at setting up a unified geodetic reference frame so that maps and other geoinformation products can be represented on the same datum. AFREF is based on satellite positioning technologies, and forms the geodetic infrastructure for multinational projects. The first target is to establish at least one GPS/GNSS station in every country. When completed, users will not be more than 1,000km from such a station, which will considerably improve the precision of the results. Five years ago, there were very few reference stations – and most of those were military ones – because of the cost of a GPS/GNSS base station: more than USD10,000 each, not including the installation and operating costs. Now more than 115 stations are operational across the continent, broadcasting to our data centres in South Africa. Through AFREF, partners such as Trimble and Ordnance Survey are helping to improve the network density.

However, even though we must recognise that the continent is still poorly mapped at scales that are suitable for operational activities on the ground, numerous spatial datasets on Africa nevertheless exist both within and outside the continent. Again, the right approach would be to start with what exists and to incrementally accrue the databases as more dynamic and more highly accurate datasets become available.

How does that apply to geo web services?
It's essential that Africa takes advantage of existing operational data products and services. European programmes such as GMES Africa, Galileo and Emetcast/Geonetcast are leapfrogging geospatial technology development on the continent. For example, to pave the way for the GMES Africa programme, the African Union and the European Union have established the Monitoring of Environment and Security in Africa project. It is a stepping stone towards promoting the delivery of operational, space-based services, including land, marine, atmosphere, security, emergency and climate services. That continental programme started in 2013 for five years, with

a budget of EUR40 million. While such opportunities are great, we must consider all projects within a holistic and purpose-driven vision and strategy towards African-led, African-managed and African-owned geospatial infrastructures, applications and services.

That sounds like a warning…
We need mutually beneficial partnerships with other continents to build sound geospatial applications. However, we must not give priority to piecemeal initiatives which stop after two to five years, when the financial support dries up, without proper ownership by Africans. It's not unusual to find that nothing remains at the end of such isolated projects, except a copy of the final report – if there is one. ◂

MEETING TODAY'S INFORMATION DEMANDS

Automated Map Generalisation

Nowadays spatial information is much more often displayed on digital devices than on a paper map. Within digital environments, users have high expectations regarding up-to-date information and consistent data when zooming in and out. The recent progress in automated map generalisation offers the potential to meet those high expectations.

'Generalisation' of geoinformation is the extraction of less-detailed data from highly detailed data to fit a specific purpose. Less-detailed data is more suitable for displaying geoinformation at small scales and for obtaining overview-like visualisations of a particular area. Interactive generalisation is time- and labour-intensive: it can take years to generalise a map at 1:50,000 scale from 1:10,000 data for a complete country. The automation of this process has therefore attracted considerable research interest over the past decades.

AUTOMATING THE GENERALISATION PROCESS

Since national mapping agencies (NMAs) traditionally produce maps at different scales, they have a high interest in automated generalisation, not only for traditional map production but nowadays increasingly to distribute multi-scale, on-demand maps

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Vincent van Altena is a senior GIS specialist at the Dutch Kadaster. He works on new developments such as automated generalisation and 3D. Vincent participates in the European Location Framework. He received a bachelor's degree in theology (2008) and is finalising his Msc in GIS with research on pruning of artificial networks using automated generalisation.

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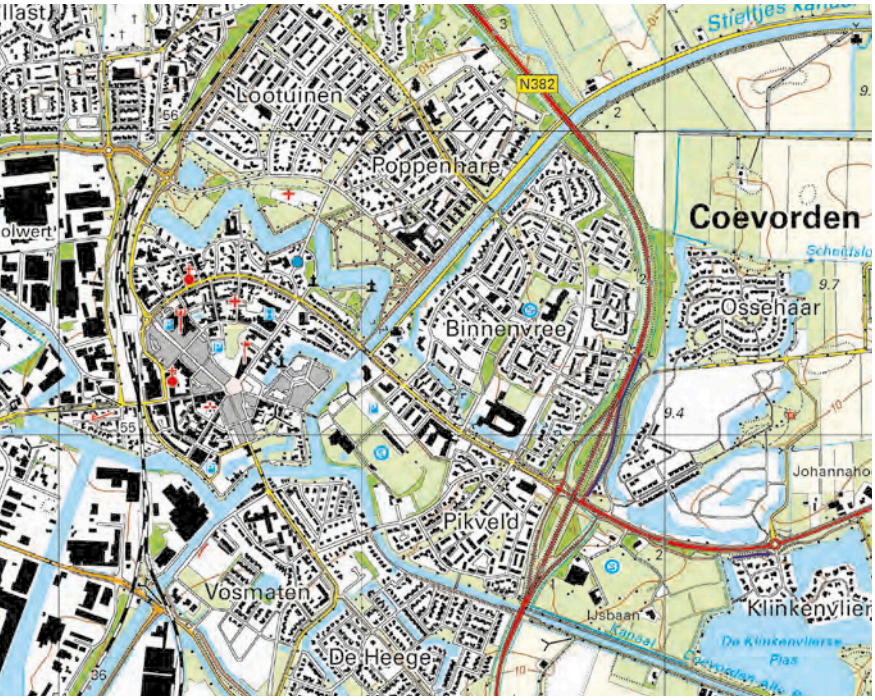


Figure 1, Source data (1:10,000) in the generalisation process of Kadaster.

within web-based environments. Automating a traditionally interactive generalisation process is not easy, since it is almost impossible to define automated generalisation rules that work for all situations. In addition, any interpretation that a cartographer can add in the generalisation process is hard to capture in code. For example, a cartographer could decide to slightly disregard the minimum size of buildings in favour of meeting a more important constraint such as non-overlapping features. It has proved to be extremely challenging to express all generalisation problems which heavily depend on the specific context in a way that can be understood by computers and to orchestrate the computation process accordingly.

FROM RESEARCH TO PRODUCTION

The gap between research and production in automated generalisation has been filled recently, and the results of sophisticated research on generalisation are being implemented in NMA production environments. One example is the VectorMap District of Ordnance Survey in the United Kingdom (OSUK), which has been in production since 2010. Every six months, OSUK automatically generalises this map at district level (approximately at scale 1:25,000) from its master map without any human interaction.

In view of the increasing amount of digital information that places high demands on actuality of the data, NMAs are acknowledging the importance of automated generalisation now more than ever. Hence, they are investing significantly in developments, as was demonstrated at the ICA/EuroSDR workshop on this topic in 2013. Huge advancements have also been made in commercial software, partly driven by collaboration projects between researchers, NMAs and software providers such as the EuroSDR project on the state-of-the-art of commercial generalisation software. Such collaborations are important because algorithms alone do not define the generalisation problem – a major role is also played by data content, i.e. data models. This requires technology experts and data experts to work together closely. Another driver of the developments in automated generalisation has been a changing view of the problem: looking at the huge advantage automation gives in terms of rapid availability of up-to-date information, solutions no longer have to be perfect but rather must be good enough.

CASE EXAMPLE: KADASTER, THE NETHERLANDS

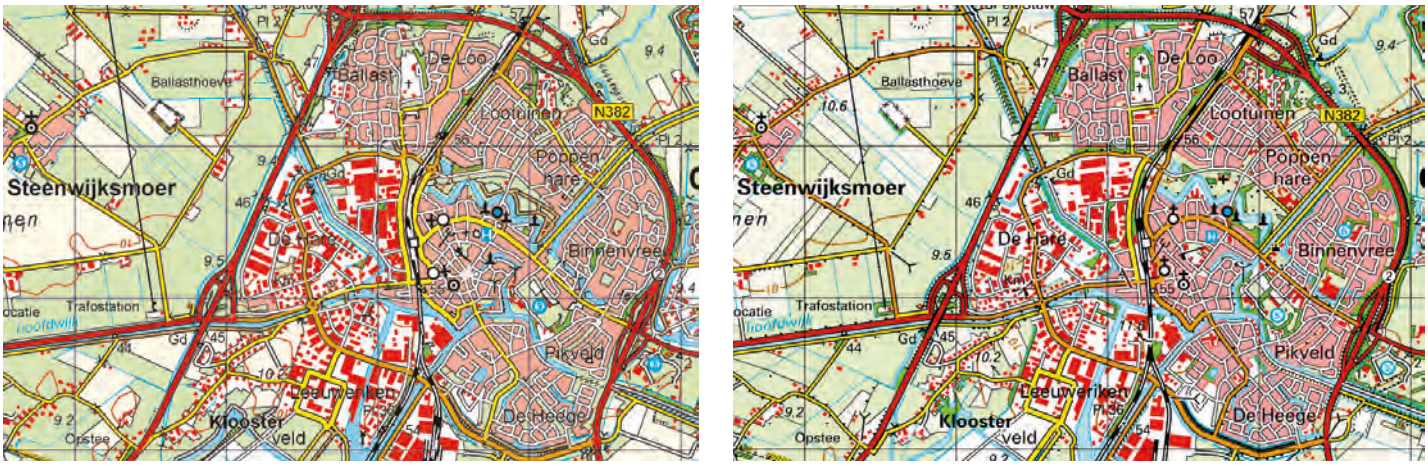
Kadaster is legally obliged to produce topographic vector data and raster maps at scale 1:10,000, 1:50,000, 1:100,000, 1:250,000, 1:500,000 and 1:1,000,000 in an update cycle of two years or less. To meet this obligation Kadaster has been converting its vectorised maps into object-oriented databases since 2007. Cartographers used to generalise the small-scale maps interactively from the large-scale map. The maps at small scale were generalised in steps from the next-larger-scale map in a ladder approach. Consequently, a long process was involved in updating small-scale maps.

To improve efficiency, Kadaster initiated a feasibility study on automated generalisation in 2010. The study focused on the workflow from object-oriented 1:10,000 data (called TOP10NL) to a 1:50,000 map. Both source and target data cover the complete face of the Earth without gaps or overlaps. A sample of TOP10NL data is shown in Figure 1.

At scale 1:50,000, symbolised features appear bigger on the map than they are in reality. This results in intense competition for space on the map and requires more generalisation operations than smoothing and thinning. It requires enlargement, typification and displacement of features in an optimisation process which takes the priority of features into account.

NOT AIMED AT REPLICATION

The aim of the automated generalisation workflow at



▲ *Figure 2, A 1:50,000 map, obtained fully automatically (A), and a 1:50,000 map, interactively generalised (B).*

Kadaster was not to replicate the existing map, for several reasons. Legacy topographic products may overemphasise past (cartographic) requirements and may ignore new requirements of multi-scale topographic information. Users may prefer up-to-date maps over maps that meet all traditional cartographic principles, although the results should still be of acceptable quality. In addition, automating a previously interactive process which was designed within a past technical and organisational context is not straightforward. Instead, Kadaster focused on solutions based on technological possibilities, combined with a willingness to reconsider the map specifications in case better results could be achieved.

Furthermore, Kadaster only accepted an automated generalisation solution that required no human interaction at all; it regarded that as the best guarantee for efficiency and consistency, and the only way to produce multiple on-demand products. For updates Kadaster preferred to completely replace the old version of the map and re-run the process, since maintaining links between different scales proved to be very difficult.

USERS' INVOLVEMENT

Since achieving user satisfaction was more important than matching existing map specifications, users were involved from the beginning. In the feasibility study, existing generalisation guidelines for interactive generalisation were implemented in an automated process using the available tooling and some self-developed algorithms. User feedback was repeatedly heeded to refine and improve the process until the result was 'good enough' and the optimal sequence of steps, as well as the most appropriate algorithms and parameters, could be integrated into one automated workflow. The workflow consists of two main models for data thinning and symbolisation & displacement, i.e. cartographic conflict resolution, respectively. The two models contain over 200 sub-models to solve each specific context-dependent generalisation problem as necessary. One example is the removal of dead-end roads: they should not be removed if the dead-end road leads to a building that is kept in the process.

'GOOD ENOUGH' MAPS

Interestingly, the evaluations showed that users appreciated the 'same appearance of the map' less than 'more frequent update cycles'. Indeed, they were willing to accept a 'good' map over a 'perfect' map, if that meant that updated 1:50,000 maps would be available two to four years sooner than is currently the case. In addition, the users were happy with the fact that the 1:50,000 maps would be 100% consistent with the 1:10,000 source data because of the synchronised releases. Some results of the automated generalisation were even valued higher than the results of interactive generalisation. For example, the automatically thinned road network appeared to be better for navigation than the interactively thinned road network, specifically for paths in forests. Finally, several respondents appreciated the improved uniformity of the whole map.

SOFTWARE AND TECHNOLOGY

For the implementation, Kadaster is using a combination of standard ArcGIS tools, self-developed tools within Python and a series of FME tools. ArcGIS contains some specialised generalisation tools, e.g. collapsing two lanes of a road into a single road line, simplifying symbolised buildings and thinning of networks. In addition, the optimisation engine available since version 10 makes it possible to select the best generalisation solution out of interdependent generalisation rules. The complete generalisation workflow is implemented within the ArcGIS Model builder tool. Examples of other optimisation-based generalisation software available include 1Spatial's Clarity (1Generalise) - which is being used in the aforementioned process of OSUK – and software developed by the University of Hannover and Axes Systems' Axpand.

ENTIRE COUNTRY IN 50 HOURS

To generalise a map for the whole of The Netherlands, the workflow is applied on about 460 generated partitions which were generated using linear objects that must never be displaced, i.e. highways and main roads. In contrast to map-sheet boundaries, such boundaries also appear in the real world and they do not clip features. Apart from some global operations that are applied for the whole country, the workflow is applied per partition and the partitions are subsequently connected.

The generalisation process of the 1:50,000 map from 1:10,000 source data for the whole country can be achieved in 50 hours in a parallel process running on six available systems that can generalise six partitions each (i.e. 36 partitions running at the same time). Figure 2a shows the 1:50,000 map that has been generalised fully automatically from the data shown in Figure 1. Figure 2b shows the interactively generalised version for comparison purposes.

CONCLUDING REMARKS

Based on the results and positive user feedback, Kadaster decided to further develop the workflow in a production environment. The organisation believes that a fully automated generalisation workflow is the only sustainable workflow for the future, as well as the only way to produce products on demand. Including pre-processing, generalisation, visualisation and printing, the entire generalisation production turnaround is three weeks for the whole country. Therefore, a 1:50,000 update is scheduled with every new delivery of TOP10NL, which is five times a year. This is a significant improvement on the two-year period required for the interactive generalisation process – which in practice turned out to take five or six years in total.

The automated generalisation approach is currently being extended to the 1:100,000 map and to on-demand products, such as the backdrop map at multiple (15) scales for the national geoportal. In addition, the intention is to generalise TOP10NL from the 1:1,000 data collected by organisations that need to maintain public spaces such as municipalities, railway companies and provinces. ◂

FURTHER READING

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PERFORMANCE ANALYSIS ON OBLIQUE IMAGERY

Dense Image Matching

3D reconstruction using dense image matching is a hot topic as it enables the automatic extraction of 3D urban models, notably from airborne oblique imagery. However, applying DIM algorithms to oblique imagery is challenging because of large scale variations, illumination changes and the many occlusions. Here, the authors present a methodology for evaluating the performance of DIM algorithms and show the initial results from four DIM packages: Agisoft PhotoScan, Leica Xpro SGM, OpenCV StereoSGBM and SURE.

Dense image matching (DIM) aims at computing a depth value for each and every pixel of an image. This facilitates the generation of accurate and highly detailed digital surface models (DSMs). Until now, the studies performed on DIM have been mainly limited to nadir imagery, with only a few studies addressing oblique images. The methodology we have developed for the evaluation of DIM solutions applied to oblique imagery includes performance measures ranging from completeness and differences in image space to density and deviations from reference geometries in object space. Deviations to planes fitted through patches lead to an indicator for a single point cloud while deviations between the DIM output and reference points or profiles indicate performance of multiple point clouds, generally from different sources.

DIM SOFTWARE

The four DIM solutions tested are mostly based on the semi-global matching (SGM) algorithm introduced by Hirschmüller (2008), and include: ▸

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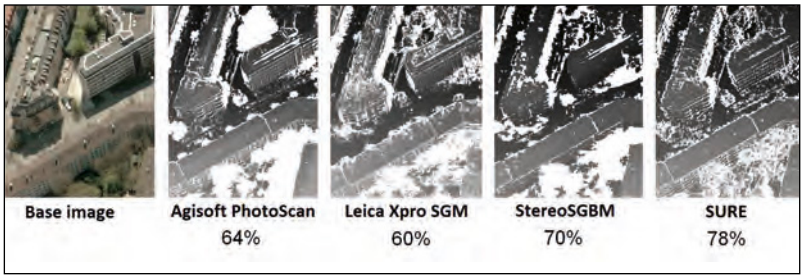
Figure 1, Test area (red), location of reference patches for scatter evaluation (yellow) and profile (blue) depicted in Figure 5.

Figure 2, Completeness of depth maps.



Task	Photo-Scan	Stereo-SGBM	SURE	Xpro SGM
image rectification	V		V	
image matching	V	V	V	V
point cloud generation	V		V	V
DSM computation	V		V	
DSM texturing	V		V	

Table 1, Tasks performed by the four packages tested.

- *PhotoScan* from Agisoft LLC implements a full photogrammetric processing chain based on computer vision algorithms
- *Xpro SGM* from Leica Geosystems, originally developed for DSM generation from ADS pushbroom data and later adopted to frame sensors, is not yet fully optimised for oblique images
- *StereoSGBM* from the open source library OpenCV consists of a simplified variant of the SGM algorithm and is limited to a radiometric resolution of 8 bit
- *SURE* from the University of Stuttgart and now distributed by its spin-off nFrames.

The workflow to arrive from stereo images to a DSM can be subdivided into five stages: (1) image rectification; (2) image matching and depth map extraction; (3) point cloud generation; (4) DSM computation; and (5) DSM texturing. The two DIM packages Agisoft PhotoScan and SURE perform all these tasks and are therefore the most complete with respect to workflow (Table 1).

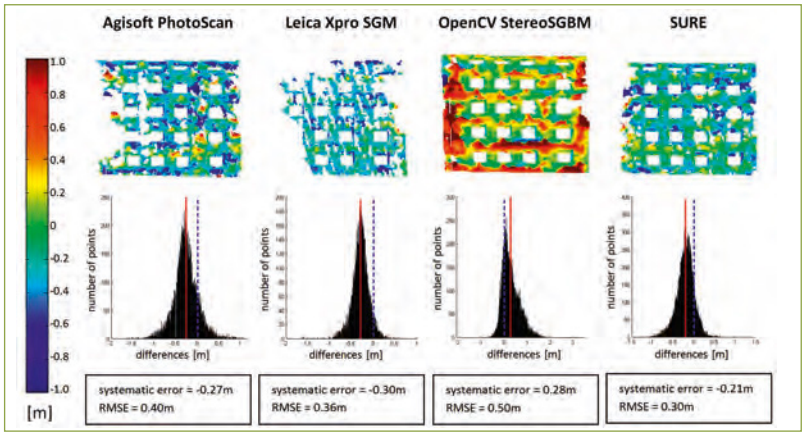
SITE AND DATA

The test area covers 5 hectares of Zürich West (Figure 1). The urban area has been recorded with a Leica RCD30 Oblique Penta which consists of five camera heads, one looking nadir and the others looking forward, backward, to the right and to the left with a tilt angle of 35 degrees. Each head has a sensor size of 60MP with a pixel size of 6 micron and a radiometric resolution of 14 bit. Images were captured with a nadir overlap of 70%/50% at a flying height of 520m. With a focal length of 53mm the ground sampling distance (GSD) of the nadir images is 6cm and the GSD of the oblique images ranges from 6cm to 13cm. Prior to matching, the images were precisely georeferenced. Reference data includes point clouds from terrestrial laser scanning (TLS) and a DSM derived from Leica ADS100 data.

COMPLETENESS AND DEPTH DIFFERENCES

Completeness is the ratio between the number of pixels to which the software assigns a depth value and the total number of pixels. Areas covered by vegetation and shadows were particularly challenging. For the whole test area, SURE shows the highest completeness with 78%, and with 60% Leica Xpro SGM shows the lowest. Figure 2 illustrates the spatial distribution of the points for which a match was found for a 0.5ha

Figure 3, Depth differences between DIM and reference points represented as maps (top), histograms (middle) as well as systematic and RMS errors.



SERIES ON OBLIQUE PHOTOGRAMMETRY

This sixth article continues the series on oblique photogrammetry performance of dense image matching (DIM) solutions applied to oblique imagery. The articles published in the January, February and March 2014 issues of *GIM International* covered properties of oblique airborne imagery, their automated processing, and automatic building detection, respectively, and the articles in the April and May issues focused on oblique camera systems. The series is a joint initiative of EuroSDR Comm. 1, Delft University of Technology and University of Twente (ITC). Edited by Mathias Lemmens the series is intended to cover the concepts, applications and camera systems and configurations currently available on the market. You are cordially invited to contribute or to convey comments or additions. To do so, please feel free to contact the editorial manager at wim.van.wegen@geomares.nl or the senior editor at m.j.p.m.lemmens@tudelft.nl.

cropping of the test area. Although the depth map of Xpro SGM shows fewer holes than that of PhotoScan or StereoSGBM, the percentage is lower as the point density in the matched areas for Xpro SGM is generally lower. Figure 3 depicts – in the form of maps, histograms and values – the depth differences for building façades generated from left-view DIM and TLS points. The systematic errors range from 21 to 30cm and the root mean square errors (RMSEs) reach up to 50cm. SURE shows the best results.

SCATTER AND DENSITY

Scatter can be computed by fitting a plane through a point cloud subset and by determining the RMSE between the points and the fitted plane. Here horizontal, slanted and vertical areas of about 10m^2 were selected as depicted in Figure 1, and the RMSE was computed for both DIM points and reference points captured by an ADS100 sensor and TLS respectively. For the forward view, street (horizontal) and roof (slanted) patches with the exception of shadow areas showed an RMSE of about 1 GSD. Larger RMSEs of 1-2 GSD were obtained for façades, i.e. vertical areas. The other oblique views yielded similar results. A further measure is point cloud density which is defined as projected points onto a plane per square metre.

PROFILES AND POINTS

Reference profiles are a proven method for analysing matching resolution, potential systematic errors and accuracy. Figure 5 shows that profiles of roof details captured by TLS and DIM profiles from oblique views correspond well. Larger differences occur in regions of building shadows (around profile position 40m). Comparing the 3D coordinates of distinct points is challenging because reference data should be homologous with points, lines and shapes generated from point clouds. Therefore, three adjoining planes such as roof parts were fitted through the respective point cloud and intersected. To obtain reliable results, scatter should be low and the number of points per plane sufficient. Table 2 shows accuracies of absolute coordinate differences of homologous points. On average, coordinate differences of 12 points per matcher and viewing direction were incorporated in the accuracy computation. The RMSEs for 3D point coordinates were 1 to 1.5 GSD horizontally and vertically, with a maximum of approximately 2 GSD.

CONCLUDING REMARKS

Absolute point accuracies are about 1 GSD horizontally and vertically for nadir and oblique imagery with camera heads facing across the flying direction, and 1 to 2 GSD for forward and backward oblique viewings. The methods for evaluating and comparing DIM performance have proven to be efficient and practical for different image matchers, for diverse oblique viewing geometries and for complex urban scenes, including building façades and other vertical structures. Parts of the methodology will be used in the upcoming ISPRS benchmark on high-density image matching for DSM computation.

ACKNOWLEDGEMENTS

Thanks are due to Leica Geosystems (Heerbrugg, Switzerland) for providing the accurately georeferenced oblique imagery and a reference DSM.

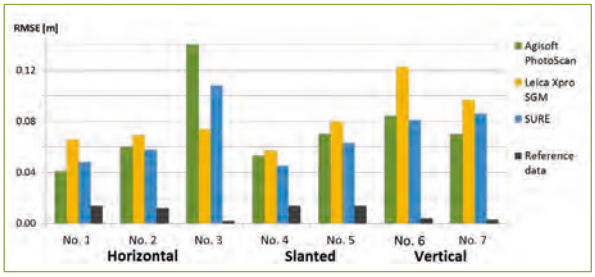


Figure 4, RMSEs of different planar patches for forward-looking imagery.

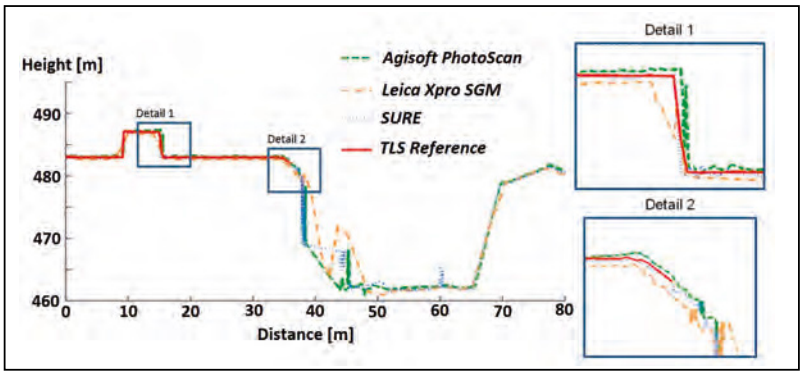


Figure 5, Profiles of roofs and a street derived from two forward images.

[cm]	GSD	Leica XPro SGM			OpenCV SGBM			SURE		
		ΔE	ΔN	Δh	ΔE	ΔN	Δh	ΔE	ΔN	Δh
Nadir	6	8	11	9	11	5	11	10	13	10
Forward	6 - 13	16	9	26	-	-	-	10	9	18
Left	6 - 13	10	6	12	11	15	9	9	8	9

Table 2, Accuracy of absolute 3D coordinate differences (RMSEs) for homologous points.

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RELEVANT TODAY AND TOMORROW?

Cadastre 2014: Nineties, Nexus and Next

Cadastre 2014 is a unique phenomenon in the land administration domain. Its striking simplicity enables it to speak to policymakers, managers and technicians alike. It enjoys an almost unprecedented role in guiding global land administration discourse, and has done so for almost two decades. In countless countries its impact upon land administration design is profound. But what about the decade ahead? Will Cadastre 2014 remain relevant? Is a new Cadastre 2014 required? What might drive such a vision? What would it include? Recent issues of *GIM International* have tackled these questions, as did a dedicated session and accompanying publication at the 2014 FIG International Congress in Kuala Lumpur, Malaysia. So, what comes next?

At the heart of Cadastre 2014 lie six visionary statements. Most observers would agree that these are still relevant in 2014. Statement 1, relating to the breadth and nature of rights recorded in cadastres, remains a central point of discussion in most developed economies. Likewise, many countries are still grappling at a strategic level with Statement 2: the need and requirement to merge mapping and registration components. The bold declarations in Statements 3 and 4, regarding the death of mapping, pen and paper, are largely correct for many contexts; however, many emerging economies continue to use manual approaches. Discussions focus on how and when a sustainable move to modelling and computerisation might be achieved. Meanwhile, in this post-New Public Management era, the relative benefits of utilising the private sector in land administration activities, as outlined in Statement 5, remain hotly contested. The same applies to the need for cost recovery as mentioned in Statement 6. Whilst examples of self-financed 'business-like' cadastres can be cited, many organisations continue to be funded through conventional means.

Although the ongoing relevance of Cadastre 2014 appears indisputable, the assuredness of the original statements is clearly up for debate. For various reasons, not all countries have fulfilled the statements. Moreover, many contexts may have no desire to implement them (yet). This tension represents strength in Cadastre 2014: the conviction in the statements provokes land administrators to take a position, which in turn promotes robust and critical discussion on the nature and design of the land administration system in question. Avoiding implementation of Cadastre 2014 neither implies failure for a country nor irrelevance for Cadastre 2014. It merely demonstrates that context matters. Since its publication in the late 1990s, increasing acknowledgement has been afforded to the importance of recognising local circumstances in land administration design. This philosophy, now embedded in the concepts such as 'fit for

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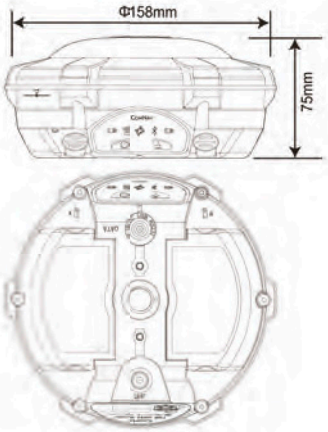

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purpose' and the 'continuums of land rights and recording', can partially be ascribed to the provocative nature of Cadastre 2014. In this regard, Cadastre 2014 will continue to retain relevance.

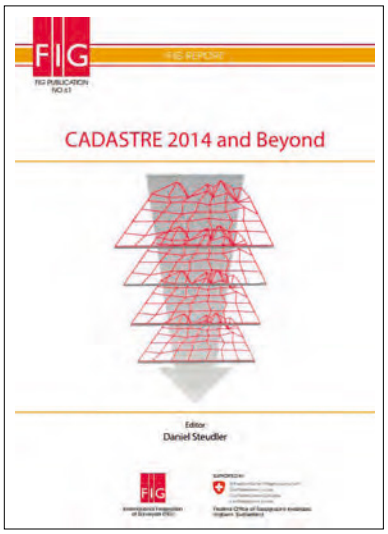
Meanwhile, Cadastre 2014 should not be reduced to its six statements alone. Behind the statements lie significant amounts of data capture and analysis. This work focused on synthesising the nature and design of many national and state land administration systems. It remains one of the more comprehensive efforts to benchmark global land administration activities. It acts as a touchstone for the range of new land administration evaluation tools being developed in the contemporary era: ones that go beyond the strategic, managerial and operational aspects of cadastres to consider actual societal outcomes. This development is perhaps the most important legacy of Cadastre 2014.

NEW VISION NEEDED?

If Cadastre 2014 remains relevant, is there need of a new vision? When work on Cadastre 2014 was initiated by FIG in 1994, the overarching aim was to forecast the role and nature of cadastres 20 years ahead. Presumably, the vision was intended as one that all countries could aspire to. However, the idea of a definitive vision for cadastres is perhaps now outdated; efforts to consolidate a cadastral vocabulary, if not philosophy in the post-Cold War period, appear to have limitations when the complexities of any national system are unpacked. The idea that a vision could enjoy a shelf life of 20 – or even ten – years can be questioned: in practical terms, most organisations do not attempt to strategically plan beyond five years. Against this backdrop, the motivation for a new version of Cadastre 2014 appears thin.

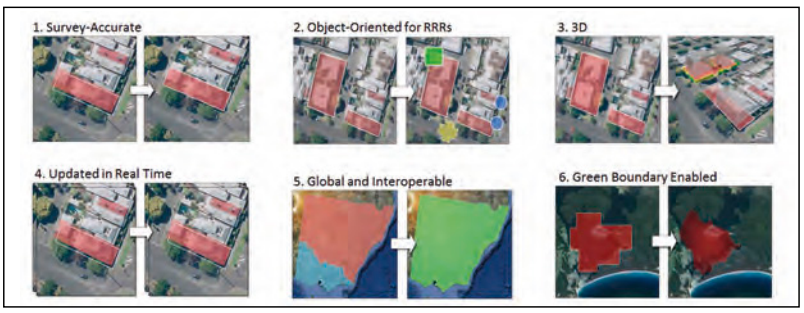
The incentive appears stronger if the vision is recast as a means for enabling global discourse. The value of a vision becomes clearer: strategic planning within countries; international and regional comparison; and plotting future research activities are enhanced. The content of Cadastre 2014 was less important than its easily accessible graphical presentation and six-statement format. It created a globally shared language for discussing cadastral systems: a long-held and defining feature of the FIG agenda. From this perspective, there is a good argument for developing new visions.

With this ideal in mind, a group of researchers instigated discussions at the 2010 FIG International Congress in Sydney (Bennett et al, 2010). The scope was limited to Australian cadastral systems. Future drivers of change were hypothesised using political, legal, economic, social, technical and environmental analytical lenses: urbanisation, unbundling of property rights, climate change, emergency & disaster response and global economic integration were all forecast. In response, and in deliberate homage to Cadastre 2014, six design elements were drafted. From the Australian perspective, future cadastres would be: 1) eventually upgraded to survey accuracy; 2) object-oriented allowing incorporation of unbundled property rights, restrictions and responsibilities; 3) capable of 3D storage and visualisation, and integrating with building information; 4) updated in real time; 5) more standardised and interoperable both nationally and internationally; and 6) required to capture and represent ecologically inspired boundaries or green property rights.



Experts revisited Cadastre 2014 in June 2014 at the XXV FIG Congress in Kuala Lumpur, Malaysia.

The preliminary vision sparked response, most prominently channelled through a series of articles and invited replies in *GIM International*. Responses were invited from key representatives of the World Bank, UN-Habitat, FAO, FIG, academia and other national land administration officials, amongst others. Some commented on the relevance of the design elements, but implied the vision was too contemporary: more innovation was necessary. More generally, the preliminary vision was misinterpreted as applying globally – rather than only to Australia, as intended by the authors. International agencies tended to criticise the vision for its focus on technological possibility, rather than the humanitarian demands of food security, clean water provision, adequate shelter and good land governance. In these contexts, 'pro-poor' and more 'fit-for-purpose' visions were required.



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From a global perspective, the criticisms were entirely relevant. There is little doubt that the largest challenges for land administration lie beyond the more-developed contexts. A cadastral or land administration divide exists; most countries do not have up-to-date information on the relationship between land and the people that use it. The information remains unrecorded and obscure to governments, citizens and potential investors alike. The situation is argued to impede many development activities.

With regards to the vision, this cadastral divide begs the following questions: can (or should) these two land administration discourses, the more-developed and the developing, be merged? Could (or would) a new Cadastre 2014 play a uniting role? Or alternatively, as they often do, will these discourses remain in disparate rooms in our conference venues? It appears there is room for discussion.

Any new vision must go beyond mere technical and organisational possibilities

THE NEW PLAYING FIELD?

The UN's Post-2015 'Sustainable Development Goals' (as they are likely to be known) will replace the Millennium Development Goals. Although they are still a work in progress, land and transparency on land ownership will be either a specific objective or a cross-cutting theme in the goals. Meanwhile, in 2012 the CFS endorsed the 'Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security'. That document says much about how land tenure and land tenure information ought to be established, protected and governed.

The UN's Post-2015 Development Agenda and CFS/FAO's Voluntary Guidelines: starting points for a new vision?

As often argued by prominent land administrator Robin Mclaren, the land administration sector is being challenged: deliver innovative ideas for accelerating land information delivery in less-developed contexts, and do it fast, cheaply and fairly.

What role can cadastres play in all this? The short answer is: potentially plenty. However, first there is a need to better marry the two forces that drive cadastral research and business: 1) the technological advancements in geoinformatics (e.g. UAVs, GNSS, HRSI, webGIS, WSNs, crowdsourcing, the cloud, Lidar, etc.); and 2) the emerging societal problems that land administration, or cadastres, can help to solve (e.g. pro-poor land tenure security, rapid urbanisation, land grabbing, food security and climate change). The Post-2015 Development Agenda provides a new impetus to fuse research and business activities relating to these new societal demands and technologies. Already, new global commercial software and technology providers are emerging with product offerings (e.g. Thomson Reuters), whilst existing players are intensifying their focus and restructuring their product offerings (e.g. Trimble).

In summary, whilst most of Cadastre 2014's six visionary statements remain highly relevant today, the assuredness in them is clearly up for debate. Discourse has moved from Cadastre 2014's one-size-fits-all approach to discussions of 'fit for purpose' and the 'continuum of land rights'. Whether any new vision could enjoy the 20-year shelf life of Cadastre 2014 is quite uncertain. If the vision is considered as a tool for generating a global discourse then motivation appears quite strong. Meanwhile, any new vision must go beyond mere technical and organisational possibilities. It must comprehensively consider the role of cadastres in pressing humanitarian demands including those described in the Post-2015 Development Agenda. Fusing these societal demands with technological possibilities is a challenge for all countries, if not all cadastres.

FIG PUBLICATION

This paper is an abstraction of a chapter in: Steudler, D., (2014), Cadastre 2014 and Beyond, FIG Publication No 61, International Federation of Surveyors.

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No 2589

SAFE NAVIGATION FOR AUTONOMOUS ROBOT SYSTEMS

Robots in Surveillance

Unmanned airborne systems operating in tandem with ground-based mobile platforms to capture an area autonomously support and improve the work of surveillance staff, repair servicemen operating in hazardous environments and many others. Yet, such systems are not widely used in civilian applications due to cost and complexity. The authors developed an unmanned ground system which – using GNSS and other positioning devices – accurately follows a pre-specified path while avoiding obstacles. Tests show that the prototype is user-friendly, safe and easy to operate.

The German SiNafaR project ('Safe Navigation for Autonomous Robot Platforms') was aimed at developing high navigation accuracy of robotic surveillance systems and their user-friendly, safe and easy operation [1]. In the project, which ran from late 2010 to January 2013 as a co-operation between Fraunhofer IIS, University of Würzburg, Zentrum für Telematik, EADS Deutschland and Wilkon, laser scanners, cameras, GNSS, INS and other navigation tools were mounted on a copter and on a four-wheeled vehicle. Combined with own software developed during the project, it was possible to achieve high accuracy both for the unmanned airborne system (UAS) and mobile unmanned ground system (UGS).

UAS AND UGS

The autonomous mobile robotic systems used within the project operate from the air and from the ground. A UAS can move quickly through the air, generates bird's-eye view images and images parallel to the terrain, and its operation benefits from the absence of obstacles at higher altitudes. But a UAS can ▸

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Franziska Klier received a diploma degree in applied media science from Ilmenau University of Technology, Germany, in 2007. She started her career as market research manager at K&A BrandResearch, Nuremberg. She has been responsible for marketing and public relations for the Power Efficient Systems Department at Fraunhofer IIS since 2011.

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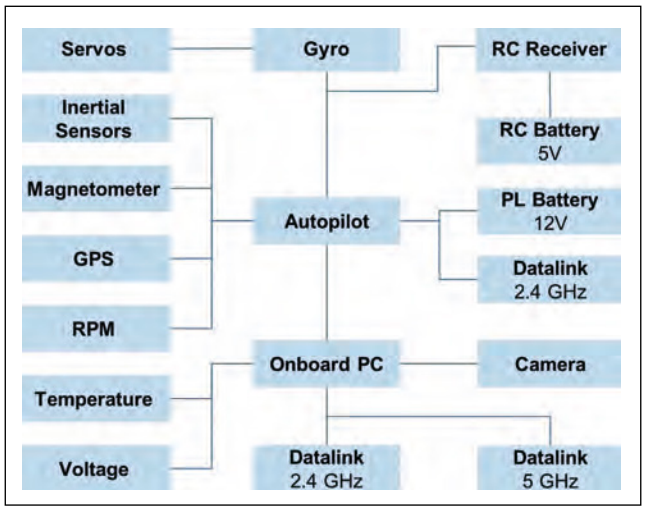
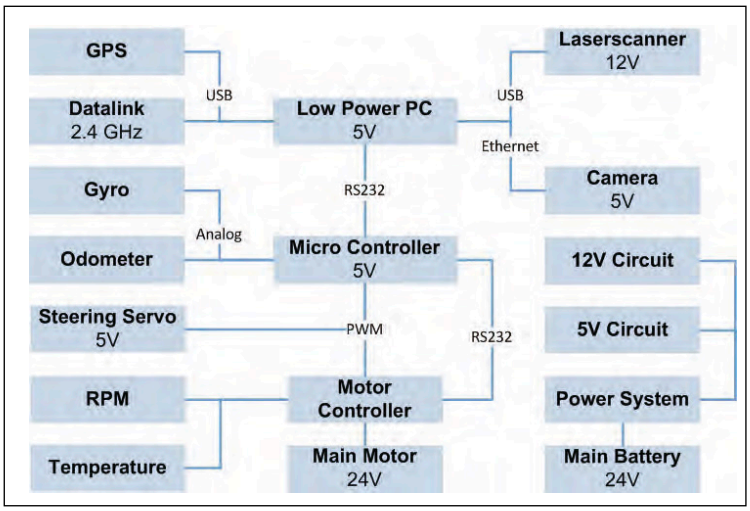


▲ *Figure 1, Schematic overview of the hardware components of the UAS.*



▲ *Figure 2, Schematic overview of the hardware components of the UGS.*

usually stay airborne for less than one hour. In contrast a UGS can operate for many hours if not days, thus allowing near-permanent surveillance. However, the data is taken from a frog's perspective resulting in much occlusion. Moreover, the wireless connection could be disrupted due to the presence of obstructing buildings and other ground structures. In the project, a fuel-powered helicopter from EADS was chosen as the UAS. Its maintenance is relatively easy, the components are inexpensive and the copter can carry sufficient payload for the purpose at hand. Figure 1 schematically shows the hardware components. The system features a commercial off-the-shelf autopilot that is guided by a pre-specified set of waypoints, which can be easily updated or adapted to flight conditions and the surveillance crew's demands. The on-board pan-tilt camera is controllable from a ground station, for example to search for obstacles on the ground that may obstruct the locomotion of the UGS. If obstacles are present, the path of the UGS may be adjusted. Tele-command and position information are transmitted through separate data links. The on-board computer handles route planning, marker detection and communication.
To meet requirements on payload and size, a four-wheeled vehicle was chosen as the UGS: the Mobile Experimental Robot for Locomotion and Intelligent Navigation (MERLIN) [5]. Figure 2 shows the hardware components of the UGS. A laser range finder is used for obstacle detection and the built-in pan-tilt-zoom camera delivers the video stream. Figure 3 shows the UAS and UGS tandem in operation.

KEY REQUIREMENT

Precise and reliable positioning of the UAS and UGS requires special attention. GNSS with the currently available GPS and GLONASS is commonly used for outdoor positioning. GNSS suffers from errors introduced by ionospheric and atmospheric distortions of signals, satellite failures or multipath effects. As the UAS and UGS move autonomously, real-time detection of anomalous or faulty GNSS signals is critical. Software was developed to detect and quantify noise, multipath or faulty signals, and these signals can be excluded from the positioning solution thus yielding higher integrity and quality. The real-time kinematic (RTK) ▶

◀ *Figure 3, UGS and UAS in tandem at surveillance; the UAS follows the UGS autonomously.*

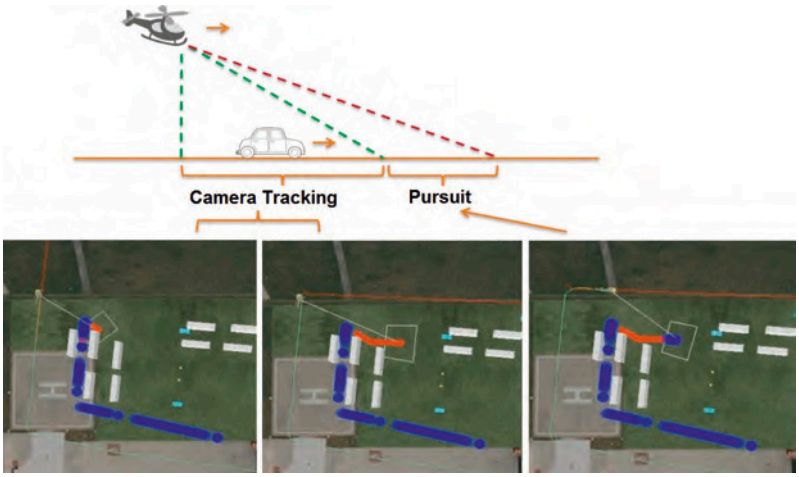
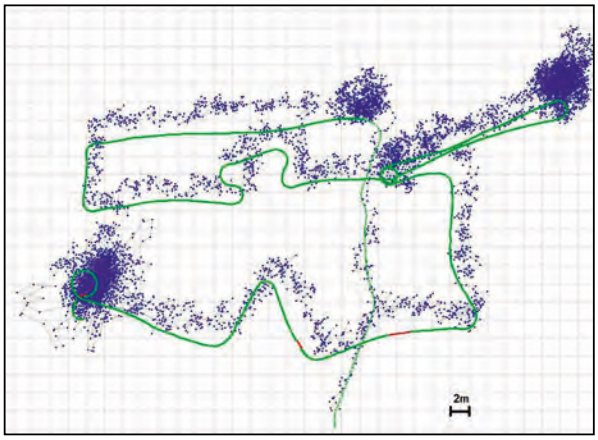


Figure 4, Simulation showing UAS path (orange line), obstacle detection and following the UGS path (red); camera footprint is indicated as a square on the surface. Right: pursuit of the vehicle when it is going to leave the tracking area to keep the target in sight. Blue: UGS track. White: simulated containers.

solution enables a quality check on the positioning data. Many errors can be eliminated with two or more low-cost GPS receivers mounted on the UAS and UGS and using a base station allowing differential GNSS. When positioning is unreliable or not available, the potentially wrong GPS data is discarded and the systems automatically switch to fall-back solutions based on one odometer mounted on the central motor axis of the UGS and a yaw-axis gyrometer. Fusion of the speed data derived from the odometer and the attitude data of the gyrometer provides position and attitude of the UGS. On the other hand, odometer and gyrometer may also provide erroneous data introduced by wheel slipping and drift, respectively. Using GNSS positioning allows these errors to be detected and corrected when they occur. Hence, by using multiple data sources combined in a sensor data fusion algorithm, positioning remains accurate even when one of the sensors produces faulty data. When the UGS does not receive sufficient GNSS signals because of driving under foliage or meeting other signal blocking circumstances, for example, the odometer data keeps the UGS on track for several metres with a deviation of just a few centimetres.

Figure 5, Comparison of standard GPS track (blue) with the low-cost RTK GPS solution (green) shown on a 2m grid.



OBSTACLE AVOIDANCE

Autonomous surveillance entails a pre-specified path, a position controller and most importantly obstacle avoidance. The latter requires the presence of 'eyes' that can capture the local environment ahead of the UGS. We compared three systems: the CamCube 3.0 [2], the Microsoft Kinect [3] and a laser scanner from Hokuyo [4]. The CamCube and Microsoft Kinect generate stereo images which potentially produce high detail; the laser scanner measures the range in slices. Theoretically the stereo images would allow the detection of subsurface obstacles. However, the images suffer from limited range and field of view and from overexposure when the sun shines directly into the camera. The Kinect is actually an indoor sensor for short ranges. Under outdoor conditions the laser scanner is superior to the 3D cameras. Therefore, the laser scanner was used as an eye for obstacle avoidance and an algorithm was developed to detect obstacles from laser scan data. Figure 4 shows a simulation in which the stationary UAS in the top-left corner (dark yellow) tracks the UGS (red dots) with the on-board camera.

USER INTERFACE

The prototype for this project, consisting of a UAS and a UGS operating in tandem, aims at assisting surveillance staff to monitor a container terminal. Since guards are not trained in operating robotic systems, the system should be as easy to control and user-friendly as possible. A browser-based human-machine interface developed in combination with the expert knowledge of a professional surveillance provider from Wilkon demonstrated the suitability of the graphical user interface (GUI) for use by laymen. Interviews with users revealed that security and easy use should be prioritised. The user interface was iteratively redesigned based on the surveillance staff's experiences. The users can adapt the on-screen layout to their personal and operational needs by changing the sizes and opening/closing tabs. A set of predefined layouts was also prepared based on the needs of flight operators, monitors of the data stream, supervisors and other possible user groups.

TEST

Figure 5 shows the path followed by the UGS during the final test. The blue dots show the positions as measured by the stand-alone, single-frequency GNSS approach. The green line shows the RTK positions. Obviously, the positions generated by the latter have a much higher precision. The trace of the UGS is easily visible. Red tracks indicate that the calculated position did not meet accuracy requirements. The final test followed a typical surveillance scenario. Although the routes between control points are pre-defined, the surveillance crew can catch up on the pre-specified route of the UGS at any time to divert to locations

that require closer inspection. The UAS operates in conjunction with the UGS autonomously to provide an additional bird's-eye view or can be used separately. The ground station manages all interactions between the UGS and UAS, and both can be tracked by the surveillance staff in the control centre or by a guard doing his rounds carrying a small handheld device such as a tablet. What the UGS and UAS see in the form of video streams is also transmitted to the surveillance staff.

CONCLUDING REMARKS

This system can be adjusted for use in other fields of tele-operation. Depending on the application, sensors for measuring gas, temperature, radiation or other phenomena can be mounted on the platforms, which can also be equipped with solar cells. The approach allows to a reduction in the resources and training costs involved in controlling and co-ordinating autonomous robot systems.

ACKNOWLEDGEMENTS

Thanks go to the Bavarian Ministry of Economic Affairs, Infrastructure, Transport and Technology, Germany, for financing the project.

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ALTUS POSITIONING SYSTEMS

Breaking New Ground in GNSS RTK

▲ *The Norway Land Consolidation Court uses Carlson Su GNSS surveying instruments.*

Altus Positioning Systems provides high-precision GNSS surveying equipment through its international sales network. Based in Torrance, California, USA, Altus is a part of the Septentrio group of companies and has primary responsibility for positioning systems in the surveying and GIS business sectors.

Altus was founded in April 2007 with a primary goal of bringing choice, quality and value to a marketplace which in many ways had consolidated in a few very large suppliers. Torrance, Altus' original home, was a logical location for the company due to its long history of involvement with satellite positioning technology: Magnavox, an early GPS pioneer, was based there, and Raytheon and Hughes had large involvements with GPS development. Within the immediate neighbourhood today are Navcom, a subsidiary of John Deere, and Antcom, a Hexagon company specialising in antenna manufacturing. This creates an environment of cross-fertilisation and a natural talent pool.

Septentrio, based in Leuven, Belgium, was founded in 2000 and was the supplier of high-precision GNSS receiver engines for Altus' family of GNSS products. Septentrio eventually became a major shareholder in Altus in 2011, expanding the company's access to leading technology and growing market access around the world. Altus originally manufactured its products in Torrance, but following tighter integration with Septentrio production now takes place in Leuven, where the group has consolidated operations.

APS-3

Altus' primary product offering is the APS-3 family of GNSS RTK receivers. The APS-3 platform provides a 136-channel GPS/GLONASS/SBAS receiver, hot-swappable lithium-ion batteries, a removable 2GB SD card and other features. There are now over 5,000 APS-3 units in use around the world. The APS-U was introduced in 2011, targeting machine control, agriculture, aerial photogrammetry, heading sensor and military applications. It was followed in 2012 by the APS-3L, the first GNSS survey receiver on the market with embedded L-band capability to work with the TERRASTAR-D differential correction service.

OPEN ARCHITECTURE

A key element in Altus' product strategy is the open-architecture design, which avoids restrictive workflows that force the user into expensive long-term decisions. The modular approach allows the user to select the most efficient field computing solution and the most inclusive survey software. As a result, Altus achieves a low cost of ownership based on an inclusive warranty policy, flexible choice of open software and the ability to work with any RTK corrections network.

Although surveying has been Altus's main focus, the rapidly growing interest in high-precision positioning has meant other segments generically entitled 'GIS' now make up a higher proportion of the business and drive

rvPC Esri OEM in use with Altus APS-3

▲ The APS-U delivers multi-frequency GNSS capability together with GNSS heading, L-Band positioning and wireless communications.

▲ The new Altus APS-NR2.

new product development. In 2013, Altus became a member of the global Esri Partner Network for the ArcGIS platform. This enables Altus to work directly with Esri users to develop and deploy seamlessly integrated solutions using Altus' GNSS surveying instruments with Esri database tools.

SERVICE AND SUPPORT

Altus now hosts the survey and GIS product management & support components of the Septentrio group and the sales team for Septentrio products in the Americas. Having been a manufacturing centre for the previous six years, Altus also has a very well-qualified service department and deals with service issues around the world as well as supporting service centres in Norway, Germany, Australia and Indonesia.

Led by Neil Vancans, founder and president of Altus Positioning Systems, Altus' open style of management and employee engagement optimises productivity with a relatively small team. Currently, there are 15 employees working in the Torrance facility, augmented by the parent company Septentrio in Belgium with a total of about 100 employees in total.

INTERNATIONAL SCOPE

Altus' main geographic markets are China, Europe, Australia and the Americas, together with Russia and Canada. Topographic, cadastral and civil engineering surveyors form the historic client base, but the introduction of the APS-U, based on the demands of the offshore positioning and marine construction market, has extended the appeal of the company's products into new areas. This has been followed by growth from the energy sector for exploration and asset management applications.

Major international deployments of the APS-3 products include the German Land Development Office for use as control in monitoring and verifying agricultural production, and the Norwegian Land Consolidation Court Division for use in supporting resolution of legal disputes over land ownership.

VIEW ON THE FUTURE

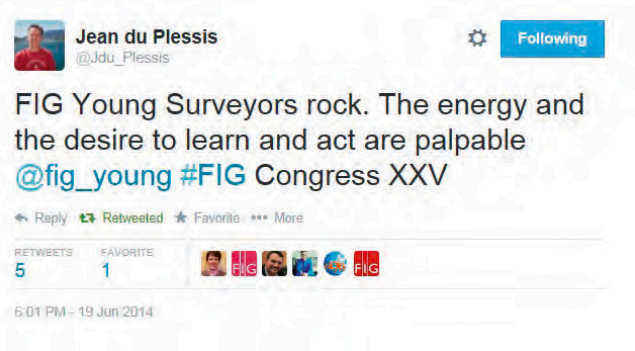
In response to the continuing trend toward open-architecture systems as well as solutions that leverage the power and flexibility of smartphones, tablets, mobile apps and 'the cloud', Altus has launched its next-generation RTK rover, the APS-NR2. It has a built-in web interface and integrated Wi-Fi for easy remote configuration and status monitoring, as well as Bluetooth for real-time data streaming. The user has a choice of Carlson SurvCE, MicroSurvey FIELDGenius or direct interface to Esri ArcGIS Online, as well as proprietary customer-developed software. Altus sees this as a major contributor to changing the paradigm associated with data capture and allowing ease of use of high-precision positioning in advanced database products with a minimum of intermediate software. ◀

MORE INFORMATION
www.altus-ps.com

International Federation of Surveyors, FIG
Kalvebod Brygge 31-33
DK-1780 Copenhagen V, Denmark
Tel + 45 3886 1081
Fax + 45 3886 0252
Email: fig@fig.net
Website: www.fig.net

Second FIG Young Surveyors Conference

The FIG Young Surveyors Network (YSN) organised its second conference as a 'Young Surveyor' stream within the overarching XXV FIG Congress in Kuala Lumpur, Malaysia, in June 2014. It was held at the Impiana Hotel, just five minutes' walk from the Kuala Lumpur Convention Centre where the Congress took place. More than 200 young surveyors from 46 countries participated – an impressive number, which helped to make this a far-reaching global event.



The FIG Young Surveyors Network reaches far beyond the conference venue.

The atmosphere was dynamic, and the participants constantly shared news, statements and reports – not only inside the venue but also through the YSN social media channels, allowing young surveyors all around the world to join in and interact. The conference offering included speed networking sessions, mentoring programmes, plenary and workshop sessions, professional development and hands-on 'How To' sessions. All the FIG bigwigs were invited to present the latest ideas and developments in a highly interactive way. The focus was on discussion and interaction between the speakers and the young surveyors after short, powerful presentations. Reflections were prepared in smaller groups and presented in plenary style.

Young surveyors (YS) around the world are very interested in the future developments and future direction of the profession where surveying is seen as the key issue. The participants were mostly young professionals just starting out in their careers or students about to finish university. The conference therefore offered attendees the possibility to get to know the latest technologies such as laser scanning, UAVs and mobile surveying as well as to build their own professional network. The societal context of the profession also received much attention. There was a multi-disciplinary approach, highlighting the broad contribution of the profession to developments at all levels in society. Visionaries including Jack Makau from Slum Dwellers International, Arnulf Christl, former president of the Open Source Geospatial Foundation, Chryssy Potsiou, incoming FIG president, and Diane Dumashie, incoming FIG vice president, joined the discussion on 'Surveying the 99%: Engaging the Need'. Leading professionals such as Robin McLaren (KnowEdge), Brent Jones (Esri), Kevin Daugherty (Trimble) and Chris Rizos (IAG) discussed the FIG publication, *Fit-for-purpose Land Administration*. Those sessions were eye-opening and illustrated to the participants the importance of the surveying profession.

In conclusion, the 2nd Young Surveyors Conference was indeed a huge success and a lot of lessons were learned by the young surveyors present. It provided plenty of opportunities for peer-to-peer engagement (YS to YS and FIG/surveying industry partners to YS as well as YS to FIG member associations) to allow them to exchange, share and discuss current and in-country challenges and opportunities related to young surveyors. It is hoped that such events may continue under the flagship of FIG and FIG YSN with more integrated and seamless programmes between the two to encourage participation by both young and experienced surveyors for the benefit of the surveying profession.

The 2nd FIG Young Surveyors Conference was hosted by the FIG Young Surveyors Network together with YSN Malaysia, and was supported by the FIG, FIG Foundation and the Association of Authorized Land Surveyors Malaysia (PEJUTA).

Eva-Maria Unger (Austria), Kate Fairly (Australia), Nur Zurairah Abdul Halim (Malaysia) and Paula Dijkstra (The Netherlands), Young Surveyors Network.

MORE INFORMATION
www.fig.net

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No 2566

Are You Being Served?

The GSDI Association is preparing a 2015-2020 Strategy and Strategic Plan for presentation to the GSDI Board in October. In a fast-changing world that is ever-more dependent upon geoinformation and geomatics technology, we realised that it was time to review the Association's fitness for purpose, aims, mission and activities to ensure that we remain relevant to current and future members, both organisations and individuals.

One of the many well-attended parallel sessions at the GSDI 14 World Conference in Addis Ababa, Ethiopia, 3-8 November 2013.

The strategy seeks to reaffirm the Association as a trusted, single source of reliable, open-access information on SDI challenges and implementation best practices from around the globe, while delivering practical member benefits. We are not alone in re-evaluating our strategy and position in the geo world and the role we can play in assisting governments and organisations in regard to SDI by knowledge sharing, while continuing to promote SDI research via our GSDI World Conferences, held since 1996.

Governments are devoting considerable resources to producing harmonised and interoperable geoinformation across a wide range of themes that reach far beyond the usual 'underpinning' themes identified in the early years of SDI development. A major challenge for the Association is extending its knowledge base to support not only those in the geo world who are involved directly in SDI implementation and maintenance, but also the myriad users of geo or location-based information globally. But who will use this information – and how? After all, information has value only when it is used.

REACHING OUT TO SDI USERS

So how can the GSDI Association extend its reach, delivering value to members and to society? There are several avenues to explore within the spirit of the new strategy, including:

- Actively participating in Open Data programmes around the world, given that government geoinformation is 'government data' first, and 'geo' second, where that data includes a location attribute. Numerous studies have been completed on the value of Open Data to governments, businesses and civil society, yet many challenges remain to be resolved in regard to implementing Open Data principles within the framework of official SDI implementations and regulations.
- Meeting the challenges and opportunities presented by crowdsourcing and VGI in developing user-derived SDI components, in support of standards-based, 'official' government SDI development.
- Closer co-operation with allied organisations involved in different SDI sectors, such as the International Hydrographic Organization (IHO) on continued development of marine SDI globally.

Our Vision … is of a world where everyone can readily discover, access and apply geographic information to improve their daily lives.

Our Purpose … is to encourage international co-operation that stimulates the implementation and development of national, regional and local spatial data infrastructures.

Our Mission … is to advance geoinformation best practices, knowledge sharing and capacity building for the improved sharing and application of geographic information.

Roger Longhorn is the operations & communications manager for the GSDI Association, vice-chair communications of the GSDI Outreach & Membership Committee and editor of the monthly GSDI & IGS Global Newsletter.

MORE INFORMATION
www.gsdi.org

The mission of the Association is the advancement of geodesy.

IAG 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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Advances in GNSS precise positioning, the availability of geodetic products from the IGS, and the easy access to the ITRF, mean that national geospatial reference frames or datums can be more easily aligned with the highest fidelity global reference frame than ever before.

Release of *Reference Frames in Practice Manual*

At the XXV International Federation of Surveyors (FIG) Congress in Kuala Lumpur, Malaysia, from 16-21 June, the *Reference Frames in Practice Manual* was released. Fundamental to any geodetic system is the spatial reference frame upon which it is based, and historically these were locally or regionally based. Through the use of global navigation satellite systems (GNSS) such as GPS and GLONASS, however, reference frames have increasingly become much more global in nature. For over two decades, the IAG's International Earth Rotation and Reference System Service (IERS) has been responsible for defining the International Terrestrial Reference Frame (ITRF). ITRF2008 is the latest version, with the release of ITRF2013 imminent. GNSS technology, when used in combination with geodetic products from the International GNSS Service (IGS) – such as precise satellite orbits and clocks, and GNSS tracking data from its global network of permanent reference stations – has made connecting to the ITRF easier than ever. This means that a nation's spatial reference frame, which allows a location to be unambiguously identified through a set of coordinates, can be aligned to the ITRF through services such as the IERS and IGS.

Within FIG Commission 5 'Positioning and Measurement' (2010-2014), the Reference Frames Working Group 5.2 identified a strong need to provide training on the topic of 'Reference Frames in Practice' to provide practical advice on how nations could use the IAG services to modernise their spatial reference frames. Three successful Technical Seminars on Reference Frames were held: the inaugural meeting was held as part of the 2012 FIG Working Week in Rome, the second was held following the 2013 South East Asia Survey Congress in Manila, and the third was held as part of the joint FIG/UN-GGIM-AP Pacific Small Islands Developing States Symposium, Fiji, in September 2013.

The XXV FIG Congress was held in Kuala Lumpur, Malaysia, from 16-21 June 2014.

Following the first seminar, a need was identified to develop and publish a manual on reference frames in the format of two-page factsheets that could be easily updated and used individually. The resulting *Manual* covers the following topics:

- Introduction
- Geodesy and global reference frames
- Global terrestrial reference systems and frames
- Regional and national reference frames
- Height systems
- Transforming between datums
- Transforming between datums in non-static reference frames
- Reference frame parameter estimation via the technique of least squares
- Least squares parameter estimates
- Global navigation satellite systems
- GNSS CORS networks and linking to ITRF
- The International GNSS Service (IGS)
- Standards and quality of terrestrial reference frames

An extremely important aspect of this *Reference Frame in Practice Manual* is as a concrete demonstration of the value of the close co-operation in recent years between IAG and FIG. Contributions to the Technical Seminars and the *Manual* have been made by IAG and FIG experts in their specific fields of interest, and it is hoped that such collaboration will continue to grow and deepen in the future. The *Manual* can be downloaded from the FIG website [1].

MORE INFORMATION
1. www.fig.net/pub/figpub/pub64/Figpub64.pdf
www.iag-aig.org

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No 2630

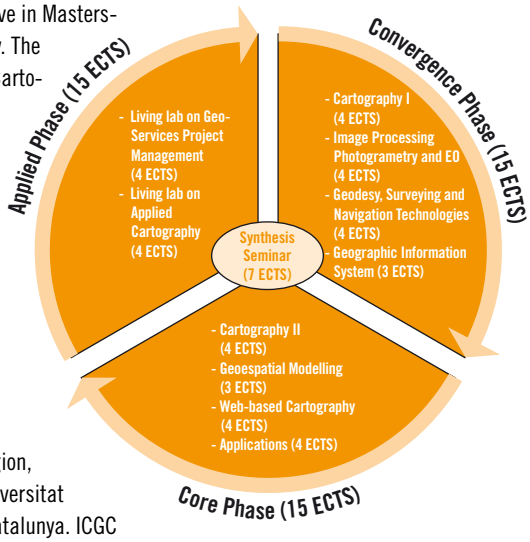
Masters of Barcelona

One of the roles of the ICA Commission on Education and Training is to keep the list of formal cartographic courses around the world up to date, ensuring that ICA – as the worldwide authoritative body on cartography – can understand, comment about and advise on the contemporary state of education in our discipline. Thus, it can be noted that much cartographic education has recently been integrated with developing syllabuses covering GIS (and this is no bad development), and that education in cartography is flourishing in some countries (e.g. Brazil, Turkey, China) whilst it is in decline in others.

It is at Masters level that cartographic students really find out about the way in which cartography is practised and applied in the 'real world', and prepare for research activity in our field. Numerous Masters-level courses (leading to an MSc or other postgraduate qualification) exist in many countries. At this more advanced level there is the possibility of attracting students from outside the home country, especially if the course is taught in a universal language such as English or Spanish.

The International Masters course in cartography jointly offered by the Technical Universities of Vienna, Dresden and Munich [1] is an innovative, contemporary and successful programme which has been offered since 2011 and already counts many nationalities among its alumni. ITC (The Netherlands), now within the structure of the University of Twente [2], has decades of experience in offering international Masters programmes to a worldwide audience.

These formal qualifications have now been joined by a further European initiative in Masters-level cartography. The course titled IC Carto-technology [3] has been developed in a partnership between Institut Cartografic i Geològic de Catalunya (ICGC), the official mapping agency of the region, and the local Universitat Politècnica de Catalunya. ICGC has 30 years of experience in setting up and building new capacities in terms of developing knowledge, infrastructures and added value in cartography. This experience is regarded as key to defining an innovative and consolidated course to track and translate current needs, requirements and geoinformation challenges into a powerful capacity-building instrument. Consisting of a total of 45 ECTS credits, delivered in three blocks (Convergence Phase, Core Phase and Applied Phase), this 12-month programme is offered through attendance at evening lectures (allowing for part-time study alongside day-time employment) for the period from October to March, followed by online engagement with material from April to June. The syllabus is wide-ranging, covering: cartographic foundations; introduction to image processing, photogrammetry and Earth observation; fundamentals of geodetic surveying and navigation technologies; fundamentals of GIS; cartography from data to management; geospatial modelling; web-based cartography; applications; practical lab on geoservices project management; practical lab on applied cartography for smart management; and a synthesising seminar (a final dissertation) on a more advanced topic, researched by the student. Successful completion of written and oral assessments leads to the Masters-level qualification.



Integrated structure of the new IC Cartotechnology course.

The course is delivered to postgraduates with some experience in geospatial sciences at the ICGC offices in Montjuic Park, in the heart of Barcelona. The lecturers come from academic institutions, from commercial companies and from government agencies across Europe. Thanks to subsidy from the Generalitat de Catalunya, the fee for the full course is EUR5,000 and it is possible to follow a selection of the modules at a lower cost.

MORE INFORMATION
1. www.cartographymaster.eu
2. www.itc.nl
3. www.iccartotechnology.com
www.icaci.org

20 Years of ARIDA with ISPRS

ARIDA (Association for Real-time Imaging and Dynamic Analysis) is a Japanese non-governmental organisation devoted to the development of the advancement of image sensing and its applications. The association's scientific interests include photogrammetry, remote sensing, spatial information systems and related disciplines. Further applications include industrial design and manufacturing, architecture and monument preservation, medicine and others.

ARIDA session during the TC V Symposium 2014.

ARIDA was established on 17 May 1994, making this year our association's 20th anniversary. I would like to take this opportunity to briefly look back on the association's activities over the past two decades. Generally, we have met every other month to share the latest developments of the related researches and technologies. Additionally, we have been making a positive contribution to the industry through frequent international seminars, workshops and so on. We have organised a total of six 'International ARIDA Seminars', namely in Zurich, Melbourne, Trento and Gifu (Japan). ARIDA's first IPSRS-related activity was to exhibit with a booth at the 1996 ISPRS Congress (Vienna). Since Prof Hirofumi Chikatsu, president of ARIDA, became the Commission president of TC V (1996-2000), ARIDA has been contributing to ISPRS events under his leadership. Six 'International Workshops with ISPRS TC V/6 &TC V/SIG' were co-organised, namely in Bangkok (Thailand), Onuma (Japan), Ayuttaya (Thailand), Kunming (China), Vulpera (Switzerland) and Pisanulok (Thailand). We have also collaborated with CIPA (The International Committee for Documentation of Cultural Heritage) for a joint workshop in Kyoto (Japan), and supported the ISPRS TC V Symposiums in 1998 and 2014. Looking back on all the activities, it is clear that ARIDA has good, strong links with ISPRS.

ARIDA intends to maintain its links with ISPRS and to continue its activities in order to strengthen and extend the relationships with related societies. Two events are currently planned:

- Joint symposium with Japan Society for Precision Engineering, '3D Laser Scanning and Imaging Symposium Japan', on 26 September 2014 in Tokyo
- Joint workshop of ISPRS TC IV/7 and TC V/4, 'Indoor-Outdoor Seamless Modelling, Mapping and Navigation', from 21-22 May 2015 in Tokyo.

The second workshop listed above will deal with a wide variety of topics including BIM/CAD/indoor GIS, close-range photogrammetry, image-based modelling, point cloud and more. You are cordially invited to attend the events and your contributions are very welcome.

Finally, I would like to express our appreciation of the generous support from Prof Shunji Murai, Prof Armin Gruen, Prof Clive Fraser, Prof Petros Patias and Dr Fabio Remondino as special members of ARIDA. ◂

Takashi Fuse
Vice president of ARIDA,
University of Tokyo

MORE INFORMATION
www.isprs.org

Future events

SEPTEMBER

9th European GIS Education Seminar
Cork, Ireland
from **04-07 September**
For more information:
E: eugises2014@eugises.eu
W: http://eugises2014.eugises.eu

1st International Geomatics Applications "GEOMAPPLICA" Conference
Skiathos Island, Greece
from **08-11 September**
For more information:
E: geomapplica@prd.uth.gr
W: www.geomapplica.prd.uth.gr

5th ESA Advanced Training Course on Land Remote Sensing
Valencia, Spain
from **08-12 September**
For more information:
E: julia.amoros@uv.es
W: http://seom.esa.int/landtraining2014

ION GNSS+ 2014
Tampa, FL, USA
from **08-12 September**
For more information:
W: www.ion.org

FOSS4G
Portland, OR, USA
from **08-13 September**
For more information:
W: http://foss4g.org

Geodesign Summit Europe
Delft, The Netherlands
from **11-12 September**
For more information:
E: fholsmuller@esri.com
W: www.geodesignsummit.com/europe

Congreso Internacional de Tecnologías de Geo Información y Gestión de Desarrollo Urbanístico
Bogota, Colombia
from **22-23 September**
For more information:
W: www.geomatica-andina.com/project/geomatica/geomatica/index.cfm

Latin America Geospatial Forum
Mexico City, Mexico
from **22-25 September**
For more information:
E: info@lagf.org
W: www.lagf.org

2014 Esri Latin America User Conference
São Paulo, Brazil
from **25-26 September**
For more information:
E: lauc@esri.com
W: www.esri.com/events/latin-america

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

AARSE 2014
Capetown, 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/

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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