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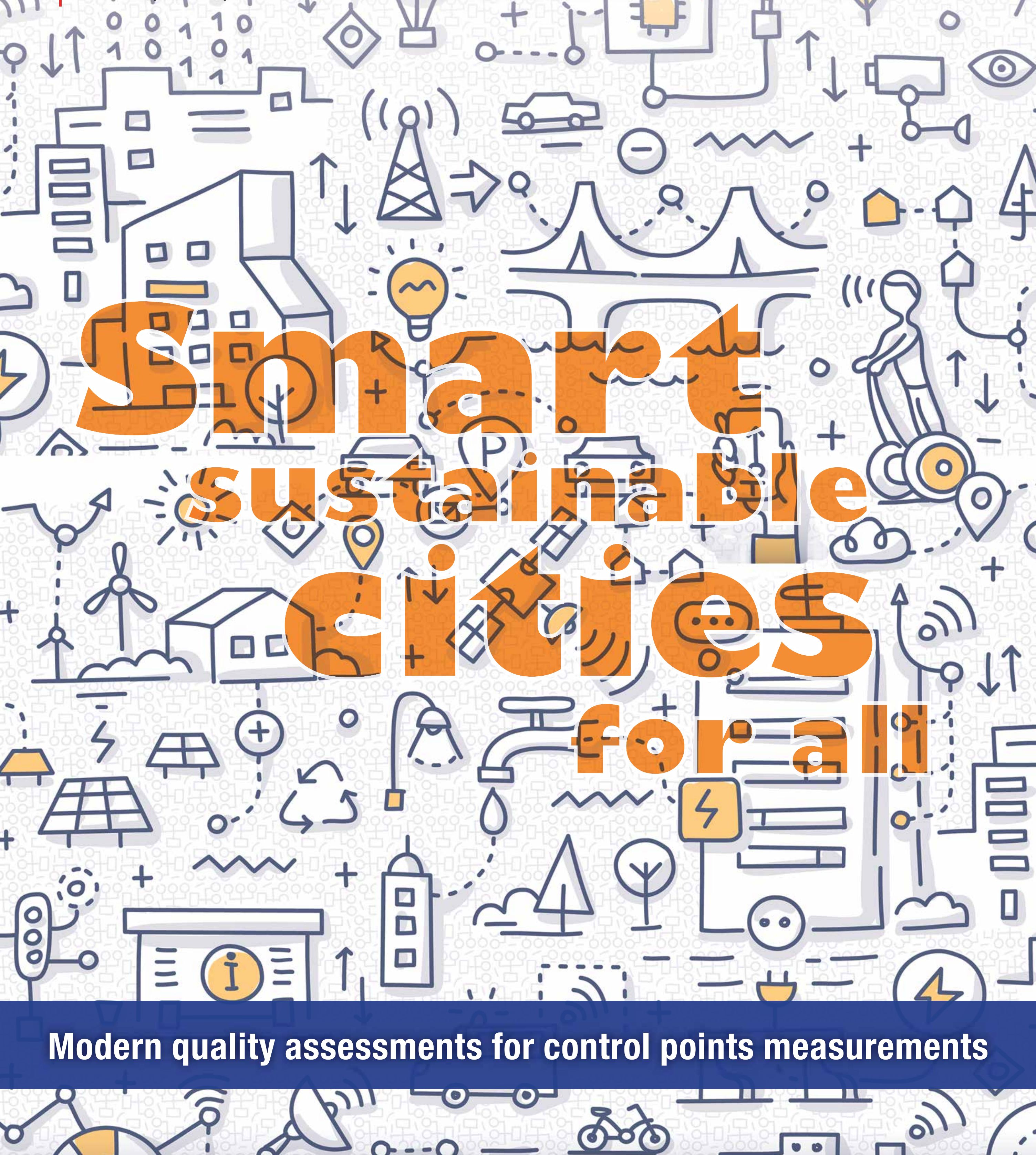

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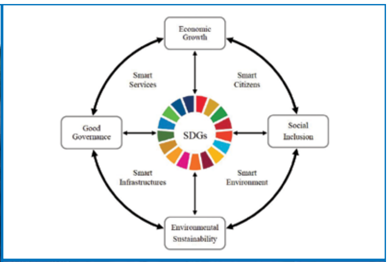

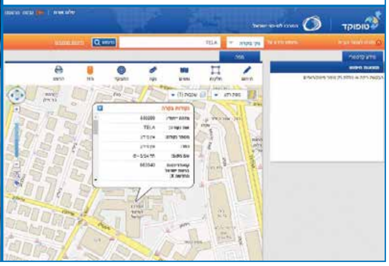

In this issue

Coordinates Volume 13, Issue 10, October 2017

Articles

Columns

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Mailing Address
A 002, Mansara Apartments
C 9, Vasundhara Enclave
Delhi 110 096, India.
Phones +91 11 42153861, 98102 33422, 98107 24567

Email
[information] talktous@mycoordinates.org
[editorial] bal@mycoordinates.org
[advertising] sam@mycoordinates.org
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Owner Coordinates Media Pvt Ltd (CMPL)

This issue of Coordinates is of 52 pages, including cover.

Facts and fictions

The booming fake content industry

Might be serving the immediate interests of the some

But will have long-term consequences,

Not only in terms of increasing distrust

For print and digital media - both

But also may have indelible marks

On unsuspecting minds.

The phenomenon will not be confined

To only political, social and economic arena

But may also engulf the scientific domain as well.

Fictions may replace the facts,

Not only in the virtual space

But in our minds, as well.

Bal Krishna, Editor
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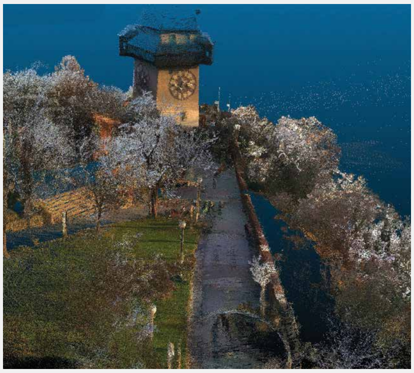

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Secure Land Rights and Smart Cities

Report of the UN-GGIM Academic Network Forum

On 31 July 2017, the UN-GGIM Academic Network, in close collaboration with and the support of UN-Expert Group on Land Administration and Management, UN-GGIM Private Sector Network, and UN-GGIM Geospatial Societies, held a Forum at the United Nations Headquarters in New York. The Forum focused on the theme "Secure Land Rights and Smart Cities – Making It Work for Sustainable Development" as part of the Seventh Session of the United Nations Committee of Experts on Global Geospatial Information Management.

The Forum brought together over 100 delegates, geospatial experts, and academics from over 50 Member States, academic institutions, and the private sector. The participants discussed three major themes: i) the challenges and shortcomings of land rights in the context of rapid and transformative urbanization; ii) the technical and social requirements of developing smart cities for all; iii) the direct link between land rights, smart cities for all, and the SDGs and potential pathways towards the achievement of the SDGs.

Objectives

As the strategic knowledge, research, and training arm of the UN-GGIM, the Academic Network organized the Forum with the following objectives:

a) Present the current status of land tenure, land rights and discuss research and practice in smart cities;
b) Establish a dialogue and exchange ideas around land rights and explore the relationships between that and smart cities to address the challenges and opportunities;
c) To identify relevant challenges and opportunities for the development of effective strategies to secure land rights and smart cities for sustainable development and build and strengthen capability concerning geospatial information and their use, particularly in developing countries;
d) To develop a roadmap that promotes the development of policies, methods, standards and mechanisms to overcome the challenges and create a better linkage between land tenure, land rights and smart cities for all; and
e) Develop a future work plan and research agenda to assist UN-GGIM and member states to respond to the SDGs.

Background

The Academic Network contributes to strengthening global geospatial information management and is committed to the achievement of the 17 SDGs. The development of future smart cities will require access to inclusive services, technologies, and infrastructures. The "leaving no one behind" principle of the SDGs intends to ensure that efforts towards a sustainable and smart future will develop a better future for all communities. Goals 1, 2, and 5 of the SDGs have designated targets and indicators linked to land tenure rights which signifies the fundamental role of land administration in building sustainable and smart cities for all. The UN-GGIM 2017-2021 Strategic Framework acknowledges the necessity of integrating geospatial information in the process of achieving the SDGs and developing future cities.

As United Nations Member States work towards a sustainable future, land tenure security is one of the greatest challenges identified in the UN-GGIM 2017-2021 Strategic Framework that requires the comprehensive management of geospatial information and resources to ensure social inclusion, economic growth, and environmental protection. The availability of effective and efficient land administration remains a problem worldwide, especially in developing countries where mature land information systems (LIS) and formal land registration systems are not available. Therefore, spatial inclusion, secure land rights, and sustainable land use are all major challenges resulting from rapid urbanization that public and private sectors need to address in the development of future smart cities. The UN-GGIM Academic Network recognizes the importance of promoting and sharing geospatial data and integration approaches, developing of legal and policy instruments, implementation of institutional management models, providing technical solution and standards, enhancing interoperability of systems and geospatial data, and improving access to quality and timely data.

Outcomes

The following points highlight the major outcomes of the forum:

a) Data is the glue that can keep together the 2030 Agenda: the development of a global data ecosystem is necessary
b) Securing and rights require: data, standards, guidelines, tools, infrastructures, targets, indicators, creation and maintenance of digital land records, and global insight—partnerships, awareness and leadership and finance.
c) The achievement of the SDGs will require: private, governmental, and academic partnerships
d) Smart cities will be feasible if good governance is in place: performance, responsibility, and transparency
e) Citizen Science is a key method of data collection: better and more relevant information
f) Legal and policy requirements: protect people against excessive or unfair private power
e) Identified the need to develop:
    - Capacity building activities
    - SDGs Research Registry Platform
    - Indicator Registry Infrastructure
    - Joint WG with PSN to address the gap between training and industry expectations
    - Joint WG with UN Geospatial Information Section to support UN Strategic Operation

For more information, please contact:

Professor Abbas Rajabifard
Chair, UN-GGIM Academic Network
abbas.r@unimelb.edu.au
http://unggim.academicnetwork.org

Smart sustainable cities for all: A socio-spatial approach

This article focuses on the potential contribution of a socio-spatial approach to smart sustainable cities in order to meet the objectives of sustainable development and smart cities for all communities in different locations

Maryam Rabiee
Visiting Research Associate at the Center for Spatial Data Infrastructures and Land Administration (CSDILA), University of Melbourne, Australia

Abbas Rajabifard
Director, Centre for Spatial Data Infrastructures and Land Administration (CSDILA), Melbourne School of Engineering, The University of Melbourne, Australia
Chair, United Nations Global Geospatial Information Management (UN-GGIM) Academic Network

The proposal of the Sustainable Development Goals by the United Nations in 2015 and the prominence of smart city projects in an era of accelerating urbanization play a central role in the development of strategic plans of action to address global challenges in all communities. This article focuses on the potential contribution of a socio-spatial approach to smart sustainable cities in order to meet the objectives of sustainable development and smart cities for all communities in different locations.

Interconnectivity of global challenges

Rapid and uneven urbanization is exacerbating inter and intra-city disparities across the world. Cities host more than half of the world population where the majority of fastest growing cities are located in Asia and Africa [1]. There has been a steady increase in the growth of urban populations in recent decades, which will continue to propel stakeholders to accelerate the development of infrastructures and services that comply with the needs pertinent to each city. The adoption of the 17 Sustainable Development Goals (SDGs) set forth by the United Nations (UN) in 2015 has presented an agenda that ambitiously intends to overcome environmental, economic, and social challenges in all nations by 2030. These global goals have emerged in a hyper-connected world in which people, information, and services are linked across different locations and sectors. This global network of communities has also intertwined the complexities of challenges that arise in different societies. Thus, economic, social, and environmental problems have embedded within them global attributes that affect the local circumstances in which they emerge.

Expanding the definition of 'global' to include all localities and populations, however, does not instinctively enact equal representation in decision-making, inclusive access to various resources for development, or endure productive and inclusive progress for everyone, everywhere. As the world becomes increasingly more connected, the divide between different cities, and their ability to meet economic, health, education, environmental, and other socio-economic demands, is swelling. Global policy frameworks have yet to bridge the divide between developing and developed countries. Moreover, the prominence of the smart city discourse, as a key driver of urban development, has the potential to widen present divides if not examined critically. Therefore, the integration of developing cities in the rhetoric of the emerging universal movement towards a sustainable and smart future is a difficult task ahead of global actors. The aim of this article is to draw attention to the connectivity of various global challenges and assert the significance of a socio-spatial approach in the development of inclusive smart and sustainable cities, which is based on ongoing research conducted by the authors in the area of sustainable development and smart cities.

The Smart-Sustainable nexus

An estimated 54.5 percent of the population of the world lived in urban settlements in 2016, while that number is expected to increase to 60 percent by 2030 [1]. It is the deployment of information and communication technologies (ICTs) and a revolution in city data that has accelerated the transformative power of urbanization and created a network of cities and citizens on local and global levels, and has paved the way for smart cities [2] as a viable solution to urban challenges. The notion of "smart city" has gained momentum over the past two decades and does not yet encompass a shared definition or a single conceptual framework. The definition of smart city ranges from the spatial-technical viewpoint of integrating ICTs in every aspect of a city [3], to a more socio-technical perspective that considers ICTs as tools that serve the citizens and their economic, social, and environmental requirements [4]. The variety of interpretations is conducive to the multiplicity of smart city priorities and applications determined by different locales. However, in the conceptualization of smart cities, the integration of alluring technologies should not usurp the smart city discourse in theory, or assume a one-size-fits-all model that can be exported from one location to another in practice.

The 2030 Agenda is also subject to different economic, environmental, and socio-cultural circumstances. The Agenda mentions that the SDGs are universally applicable to all Member States and take into account different national realities, capacities and levels of development [5], and vows to leave no one behind. The 17 SDGs, 169 targets, and 232 indicators intend to achieve economic growth, social inclusion, environmental sustainability, and according to some scholars, good governance [6] and aim to put into action inclusive strategic planning everywhere to ensure that everyone benefit from the outcomes of sustainable development. Recognizing the universality of the SDGs framework and smart cities projects, and their overlapping components, suggests that there may be potential benefits in aligning smart city planning with the SDGs implementation process to increase the effect of progress and impact.

The International Telecommunication Union (ITU) and United Nations Economic Commission for Europe (UNECE) have merged smart and sustainable aspects of a city to define a smart sustainable city as, "an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects" [7]. In line with the proposed definition, Figure 1 demonstrates the relationship between the SDGs framework and the worldwide trend towards smart cities. In attempts to put the conceptual understanding of this notion into practice, the pressing question of how to ensure a smart sustainable future that is inclusive of all cities, and above all, developing cities, is a critical problem the global community has encountered. This article, therefore, takes a socio-spatial approach to smart sustainable cities to study the connection between social elements of development and the spatial elements of urbanization.

In the smart and sustainable transition of cities, spatial location is an urban feature that determines the development and efficiencies of its functions. While Goal 11 of the SDGs calls upon nations to overcome the urban challenges of building sustainable cities and communities, the problems associated with each of the remaining 16 SDGs are associated with spatial location and thus play a significant role in urban development. The spatial interpretation of social, economic, environmental, and governance challenges in the context of "smart cities for all" call attention to some of the socio-spatial dimensions of inclusive progress, such as spatial technologies and geospatial information across all levels of society, infrastructures that utilize a correlated language of conceptualization in their technical applications, and platforms capable of registering and sharing indicators that monitor and measure smart and sustainable progress.

Socio-spatial enablers

Understanding the variety of socio-spatial dimensions involved in the development of smart and sustainable solutions is subject to mobilizing a culture of change through informed citizen engagement, evidence-based policy making, efficient infrastructures, and effective methods of progress assessment. Data ecosystems play an integral role in mobilizing change and monitoring progress [5]. Spatial data, in particular, is required for a number of the

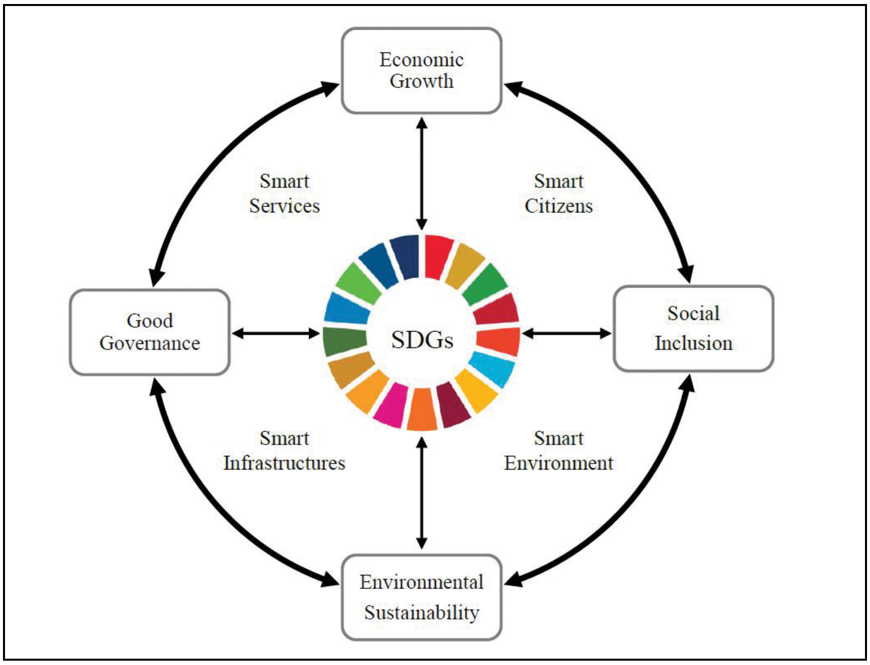

Figure 1: The relation between smart city components and the SDGs

SDGs indicators [8], and essential in the urban context. Therefore, linking together spatial enablement of urban populations, ontology-based infrastructures, and indicator registration platforms will have the potential to facilitate the development of solutions for a wide range of challenges. Figure 2 illustrates the potential relationship between three socio-spatial enablers that can direct the progress of smart city and SDGs initiatives towards inclusive and productive advancements.

Spatially Enabled Society (SES)

Geographic factors have different forms of impact on the socio-economic conditions of any population [6]. The empowerment of societies and involvement of more citizens in the development of smart sustainably cities can be made possible by spatially enabling societies, which can subsequently increase the representation of citizens, nations, and regions that have not received equal opportunities in development initiatives in the past. A spatially enabled society in which "location and spatial information are regarded as common goods made available to citizens and businesses to encourage creativity and product development" [9] detects the location of its members' needs more effectively, increases accessibility to data and services, and is more inclusive of all levels of society. Incorporating advanced ICT applications that spatially enable urban populations is one of the fundamental elements that satisfy a city's 'smart' requirements [10] and fosters shared, integrated, and analyzed spatial data in order to provide the basis for value-added services that support sustainable development [11]. Consequently, applying the concept of spatially enabled societies in practice accommodates a more people-centric approach to smart sustainable cities.

Ontology-based infrastructures

The globally connected network of smart sustainable city applications necessitates ontologies. Ontologies provide a correlated understanding of a concept, its limitations, and logical relations with other conceptual entities within a specific domain that is also machine-understandable. That is to say, "an ontology is a formal, explicit specification of a shared conceptualization [12]. In addressing global challenges, a shared understanding of concepts strengthens international cooperation in mobilizing resources and developing strategies to build smart sustainable cities. Ontologies can harmonize the concepts and terminologies used in the SDGs and

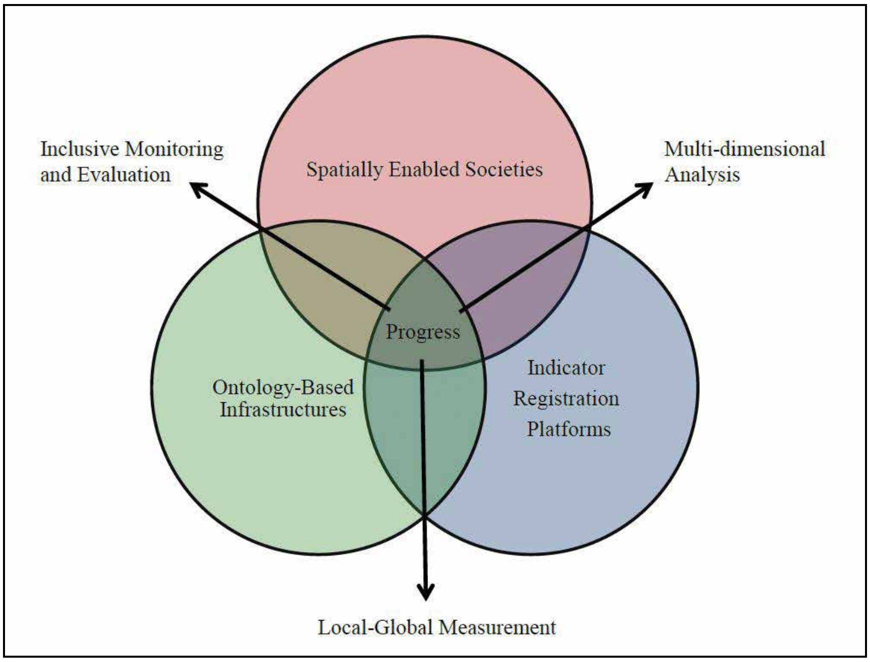

Figure 2: Three major socio-spatial dimensions of inclusive progress

facilitate the integration of infrastructures that are adaptable, scalable, and capable of operating in diverse settings. The United Nations Environment Programme (UNEP) is building a Sustainable Development Goals Interface Ontology (SDGIO) to investigate and provide a clear definition of terms used in the SDGs in a coherent manner to prevent ambiguity when using data and developing policies [13]. Ontologies broaden the scope of measurement and comparability to a global level, however, the effort to elucidate the meaning of SDGs terminology should not result in overlooking the locality and cultural context of SDGs concepts.

Indicator registry platform

Countries strive to improve the circumstances of the citizens and their progress is compared by national and global measures. Indicators are the means to evaluate the scale of a city's sustainable and smart attainment and support the development of evidence-based policymaking and concrete actions plans. Evaluating the progress of the SDGs from a local to global scale can be achieved by developing an infrastructure as an enabling platform that plugs into heterogeneous datasets within different jurisdictions to work with an ecosystem of re-usable and shared set of user-generated tools for the measurement, storage, comparison, and effective communication of its indicators for UN Member States. Further work is required to develop an infrastructure and a one-stop platform that allows different levels of government to access a set of easy-to-use interfaces to connect and harmonize their data and employ them for series of urban analytics in order to measure, compare, monitor, and communicate the SDGs indicators. The inability to monitor progress at local, national, regional, and global levels will increase the possibility of leaving behind populations that are continuously lagging behind.

Smart sustainable cities for all framework

The interconnected nature of smart sustainable cities and the confluence of local and global factors affirm the urgency of developing multi-sectorial initiatives for achieving smart and sustainable cities for all. The following framework (Figure 3) highlights the immediate prerequisites for operationalizing and progressing smart and sustainable initiatives by accommodating compatibility of various national systems within global agendas. This approach can impact the framework and drive towards a smart and sustainable world, in which the continuity of societies is contingent upon not only local knowledge and culturally specific infrastructures, but also the connectivity of challenges on a global scale.

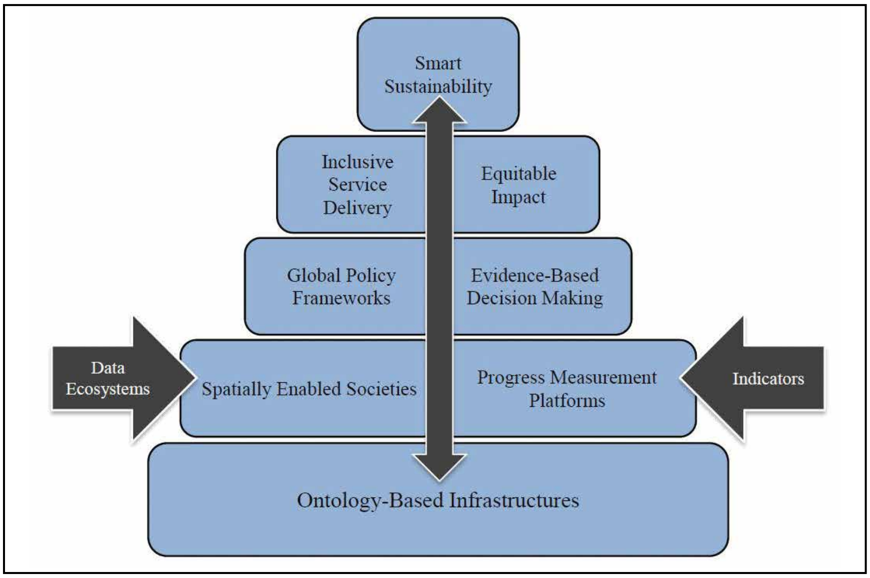

Figure 3: Smart Sustainable Cities for All Framework

In this context, the Center for Spatial Data Infrastructures and Land Administration (CSDILA) at The University of Melbourne in collaboration with five other Australian Universities (The University of Melbourne (administering organization), The University of New South Wales, The University of Queensland, The University of Western Australia, University of Wollongong, and University of Canberra.) developed the Urban Analytics Data Infrastructure (UADI) to enable the integration, harmonization, connectivity and scalability of multi-source urban datasets. This digital infrastructure, is an ecosystem of tools and multi-sourced data that are designed to work together in spite of their semantic and syntactic heterogeneity to measure and monitor urban performance indicators. The capabilities of the infrastructure are predicated on the adoption of ISO standards, development of new ontological frameworks, and an urban data dictionary to enable semantic inferencing of datasets and the development of data structures and services. The UADI can underpin a decision-support-system in the process of building smart, productive, sustainable, and resilient cities.

Geospatial experts expressed the need for urban data infrastructures such as the UADI in the implementation of the SDGs at the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) Academic Network (http://unggim.academicnetwork.org/) Forum titled "Secure Land Rights and Smart Cities–Making It Work for Sustainable Development", as part of the Seventh Session of the UN-GGIM held in August 2017 at the UN Headquarters in New York. The UADI received support for its ability to produce comparative and multi-dimensional analytics of data relevant to people, spatial location, and urban infrastructures, which increases the formation of plausible and context-specific implementations necessary for smart and sustainable cities. Most importantly, the integration of such platforms will encourage the global community to standardize measuring and monitoring progresses to be inclusive of all Member States in the evaluation process.

Conclusion

The ambitious attempt to build sustainable, smart, inclusive, and resilient cities is a multi-dimensional mission that consists of complex and intertwined challenges. Universal frameworks do not ensure that action towards achieving global goals will reach every population equally. Local, national, and global stakeholders must take advantage of the emerging and growing local-global network and strive to meet the SDGs and smart city objectives through a contextual lens. If universal frameworks and projects aim to uphold the "leaving no one behind" promise, future infrastructures, technologies, and policies must shift away from selective efforts and aid to encompass inclusive and multi-level mobilization that address social, economic, technical, spatial, and other dimensions of different problems. Incorporating the socio-spatial approach in smart sustainable cities will lead a course of action that engages different levels of societies, and their various capabilities, in overcoming urban challenges in future cities. Consolidating the position of local knowledge in the global context, employing technologies as tools to serve the people, and enhancing the harmonization, connectivity, and scalability of data are enablers that assist cities and citizens with the means to direct future developments. Therefore, the contribution of concepts and infrastructures that emerge from spatial research and innovation are fundamental to the multi-dimensional and all-inclusive progress of SDGs and smart city goals.

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The potential use of VGI data for 3D cadastre surveys

This study presents an evaluation of the current state of the art of algorithms and techniques used for 3D modelling and investigates the potential of their usage for 3D cadastre. We have presented this paper in two parts. In the last issue, the progress realated to utilize VGI data in visualizing the 3D world was published. The algorithms and techniques in 3D reconstruction which may be used to provide accurate and detailed 3D models were also discussed. In this issue, the potential of using VGI data in 3D reconstruction procedures, indicating the advantages and disadvantages of this approach is published, in addition to the potential of using VGI data for 3D cadastral surveys

Maria GKELI
Surveyor Engineer, PhD student, School of Rural and Surveying Engineering, National Technical University of Athens (NTUA), Greece

Charalabos IOANNIDIS
Dr Surveying Engineering, Professor at the Lab. of Photogrammetry, School of Rural and Surveying Engineering, National Technical University of Athens (NTUA), Greece

Chryssy POTSIOU
Dr Surveying Engineering, Associate Professor, School of Rural & Surveying Engineering, National Technical University of Athens (NTUA), Greece

VGI as a data source for 3D reconstruction

The VGI approach to photogrammetry poses additional challenges, because the data are not recorded according to photogrammetric requirements. While contemporary software can deal with difficulties like unknown and varying focal length, lighting changes, and incompatible images (images of different scale), a number of common problems remain.

Many amateur digital cameras (including those on cell phones) have a cheap, consumer-grade single-frequency GNSS receiver, and sometimes the GNSS coordinate at the time of taking the picture is stored as metadata in the image's EXIF header. These coordinates, sometimes referred to as geo-tags, are currently not available for the majority of images and they are not accurate enough to be used directly – errors in some cases exceed 10 m. But, just like the approximate focal length that is also often part of the metadata, they are good enough as initial values, and can constrain the problem sufficiently to overcome some of the problems mentioned above (Hartmann et al., 2016).

Camera pose estimation and 3D reconstruction from arbitrary, uncontrolled images has reached a certain maturity, as evidenced by several open-source and commercial software packages (e.g., Bundler, VisualSFM, Pix4D, Acute3D, Agisoft PhotoScan). Nevertheless, a number of important open problems remain, which is the reason that crowdsourced photogrammetry has not yet been widely adopted for surveying purposes. The main issues in our view are: (i) more often the models are incomplete and show only some of the sides of a building or scene; (ii) repetitive structures and symmetries lead to incorrect correspondences and gross errors (e.g., missing parts) of the 3D models; and, (iii) even if several useful parts of a larger scene have been reconstructed correctly, the models are not geo-referenced with appropriate accuracy. In order to overcome the abovementioned problems, Hartmann et al. (2016) proposed a method for the creation of geo-referenced 3D models using images from Flickr, which has been the major data source for crowdsourced photogrammetry. As a first step, the dataset divided into smaller clusters, using VocMath method (Havlena & Schindler, 2014), which provide the set of images from each camera pose. The small, clean clusters are individually reconstructed using a SfM software (Bundler) (Snavely et al., 2008). Each of these models represents a part of the same landmark. The GNSS coordinates from the EXIF headers of the images are exploited to perform a coarse absolute orientation. For the absolute orientation between the partial 3D models, Hartmann et al. (2016) proposed to go back to the models and find corresponding 3D structure points for a better alignment. The point-to-point correspondences identified using the standard SIFT algorithm. Finally, the geo-referenced 3D model derived after a bundle adjustment, so as to fuse all available information. Also, similar research has been performed over time (Hadjiprocopis et al., 2014; Somogyi et al., 2016).

Jeong & Kim (2016) proposed a planar fitting-based semi-automatic reconstruction process using smart devices, such as smartphones. The proposed methodology was developed as a mobile application for Android, and requires from user to obtain two images of the target building from two different perspectives, so each one of them may display a different side of the building and have a sufficient overlapping part. After the selection of the boundaries of the Region Of Interest (ROI) on the mobile device screen from the user, the creation of the 3D reconstruction is performed by means of the estimation of 3D surfaces function for each building side. Following, the two resulting surfaces are adapted to both surfaces of a cube. This stage is necessary to reduce errors due to some erroneous correspondences and the angular errors introduced in the process.

Zhang et al. (2016) suggests a solution to complete building reconstruction of both rooftops and façades by combining aerial-borne LiDAR point clouds and ground image point clouds generated from smartphone images, using region growing method (Segmentation based Method). First, the smartphone images are clustered by GPS data obtained from image metadata (EXIF data). Every building is reconstructed by Structure from Motion (SfM) and Patch-based Multi View Stereo (PMVS) algorithms from a clustered smartphone image set (Furukawa & Ponce, 2010; Furukawa & Hernández, 2015). The corresponding LiDAR point cloud is extracted by using the GPS data and the image pointing information obtained from the clustered image set. Building LiDAR points are segmented to possibly different individual buildings after processing by a region-growing algorithm on the building point class. Following this stage, two forms of top view 2D outlines of target building are respectively extracted from LiDAR point cloud and ground image point cloud. In order to accurately integrate the LiDAR point cloud and ground image point cloud, they adopt the Coherent Drift Point (CPD) algorithm to match building outlines extracted respectively from LiDAR point

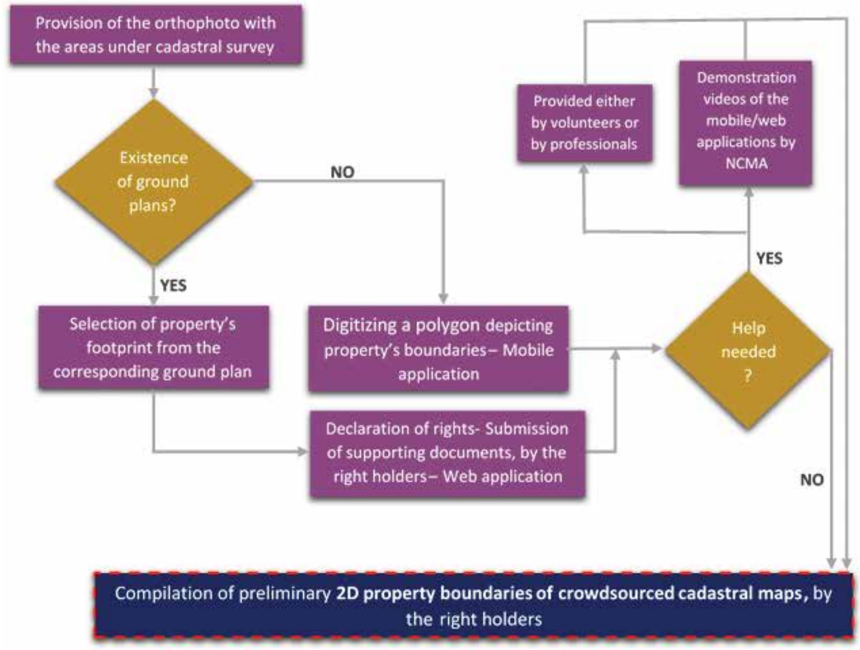

Figure 7: Phase 1 of the proposed framework for the implementation of 3D crowdsourced Cadastre.

cloud and ground image point cloud. The proposed methodology is applied to one building at a time. In the future, it is expected to be applied on a larger scale.

Occasionally, several different research approaches aim at the partial or fully 3D reconstruction of buildings utilizing crowdsourced data are proposed. These investigations concluded that the use of crowdsourced data may lead to satisfactory results, constituting an important part of the 3D reconstruction. Nevertheless, it is obvious that data collected through VGI contain noise and occlusions; so photogrammetric building reconstruction may be difficult using exclusively these row data. The presence of occlusions requires sophisticated techniques and algorithms for data processing, and may thus lead to erroneous reconstructions. The implementation of Data-driven techniques and algorithms for the development of 3D models for cadastral purposes (3D cadastre) requires especially high computational costs in order to reduce as much as possible the imported errors. However, the 3D cadastre may aim at preserving property rights, without being interested in architectural details of property geometry. Instead the key elements of interest may be the volumes of the buildings (in LOD1 or LOD2), so that the individual properties can be correctly registered. For this reason, the use of Model-driven approaches may be preferable, since they are characterized by higher stability, maintenance of the topology, while offering an easy way of 3D reconstruction which can be adopted by ordinary citizens without specific photogrammetric skills.

The potential use of VGI data for 3D cadastre surveys

While the activities of the various VGI communities has not substantially changed the way bodies such as National Mapping Agencies (NMAs) produce data, change in the future is anticipated (Foody et al., 2015). As cities expand vertically, safeguarding of tenure requires a clear 3D picture in terms of property rights, restrictions and responsibilities (RRR). However, the Land Administration Model (LADM ISO 19152) provides only an international generic framework for cadastres and there are still several aspects that need to be investigated and improved (Oldfield et al., 2016).

A 3D cadastre system should enable archiving, visualization, queries and analysis of 3D structures on different temporal time-stamps. Until now, 3D systems focus on 3D modelling of physical real-world objects (building), without paying much attention to their multi-dimensional implementation (Jaljolie et al., 2016). One of the costliest phases of the implementation of 3D cadastres, is the initial 3D data capture. In order to overcome this difficulty and establish 3D cadastres, the minimization of the financial and human resources is required. In developing countries low-cost and existing sources of data should be leveraged. With low-cost sensors and cameras which are often available in today's smartphones, the acquisition of 3D data becomes possible for a wider audience, such as citizens. This allows, for example, the reconstruction of 3D objects based on 2D images taken by low-cost sensors (Uden & Zipf, 2013). This may complement the data collection procedures of the property rights information so as the property's geometric information. Moreover, for the implementation of 3D cadastres, 3D data collected in other areas (BIM, IFC CityGML files, IndoorGML, InfraGML and LandXML) can be used for the creation of a 3D cadastral database (Dimopoulou et al., 2016). In this way photogrammetric expertise may contribute by submitting or uploading 3D models in a specially constructed 3D cadastral database.

Ideally a platform for the storage of 3D building models and the corresponding cadastral information should be developed. The cadastral surveys may be conducted in two different phases. In Phase 1 (Figure 7), right holders may be asked to collect and submit information about their own properties, as proposed from our previews work (Apostolopoulos et al., 2015; Gkeli et al., 2016) for the implementation of 2D cadastre. As basemap a recent orthophoto depicting the area under cadastral survey, ovelayed with buildings ground plans (if exist any) can be used. Otherwise the demarcation of property boundaries can be conducted by the right holders at real-

Figure 8: Demarcation of property boundaries from volunteers using a mobile application.

time on the basemap, using a cadastral mobile application where properties are clearly recognized. An example of such mobile application is the *BoundGeometry application*, which is developed by the authors and succesfully used in different areas of interest (Apostolopoulos et al., 2015; Gkeli et al., 2016) (Figure 8). The registration of supporting documents and additional information proving their rights, may be done through a web application. If the right holder is unable to use any of the applications he/she may request assistance. A person who may manage the applications, a local trained volunteer, a local professional surveyor may help the property owner. Also, demonstration videos with detailed instructions for how to use both applications may be provided to the right holders. By the end of this phase (1), a draft crowdsourced cadastral map may be produced.

In Phase 2, right holders will be asked to create or import into the platform the 3D models of the properties they have rights on (Figure 9). The commencement of this process begins after the selection of building footprint by the property owner, as declared in phase 1. With the selection of building footprint on the basemap, the collection of the respective coordinates and the building properly georeferencing is conducted. If the right holder has photogrammetric skills or he/she has 3D data collected for another application (BIM, IFC CityGML files, etc.) can contribute by creating and/or uploading 3D models in a 3D cadastral database through a specially constructed web application. If the right holder is not a photogrammetric expertise, the development of 3D models can be done utilizing parametric methods, such as discussed in chapter 3, as they constitute an easy, user-friendly and robust reconstruction process. The parametric modelling may be done through a mobile application. Using the Model-driven approach, the right holder can select the building parts from a predefined building library, and place them over the corresponding building footprint. For this reason, additional data, such as building height and ridge type, has to be entered in the mobile application in order to conclude in a successful scaled reconstruction. In addition, the right holders can take pictures using the mobile application, in which all the details of the building geometry are presented. Using these images, if is necessary, the creation of textured 3D models is possible. If the right holder is unable to use any of the applications he/she may request assistance as reffered in phase 1. By the end of this phase (2), crowdsourced 3D building models may be produced, for the initial implementation of 3D cadastre.

There are many investigations referred to different available tools in the innovative field of 3D-VGI, which can be exploited and inspire researchers in order to use the advantages of VGI data for the fast, economic and reliable implementation of a EU desired 3D cadastre (Over et al., 2010; Fan & Zipf, 2016; Uden & Zipf, 2013; Eaglin et al., 2013; Hadjiprocopis et al., 2014; Somogyi et al., 2016; Hartmann et al., 2016; Jeong & Kim, 2016; Zhang et al., 2016). Therefore, it is evident that VGI data have much potential for supporting 3D cadastre surveys and may be involved in the development processes of a 3D cadastre. Leveraging VGI data along with existing reconstruction methods (Neo-photogrammetry: Leberl, 2010), an innovative and effective framework may be produced, in an economical, easy and efficient way, wherein citizens and particularly the property owners will have a decisive role.

Conclusions

The establishment of a 3D cadastral information system aims to support government administration to provide an efficient and transparent system which can manage modern urban reforms. Two-dimensional registration of existing cadastre systems has to be improved in order to manage more complex areas with multiple levels of right. A cost effective solution is required for the initial implementation of a FFP 3D cadastre. With low-cost sensors and cameras, which are often available in today's smartphones, the acquisition of 3D data becomes possible for a wider audience, such as the occupants and right holders. Leveraging VGI data along with existing reconstruction methods, an innovative and effective framework may be produced, in an economical, easy and efficient way, wherein property owners will have a decisive role. Through proper training and education of property owners together with the development of innovative techniques and algorithms for data processing and development of 3D models, the reliability of cadastral surveys increases. Thus, utilizing crowdsourced data an affordable, usable, reliable and functional procedure for the compilation of 3D cadastral surveys may be designed.

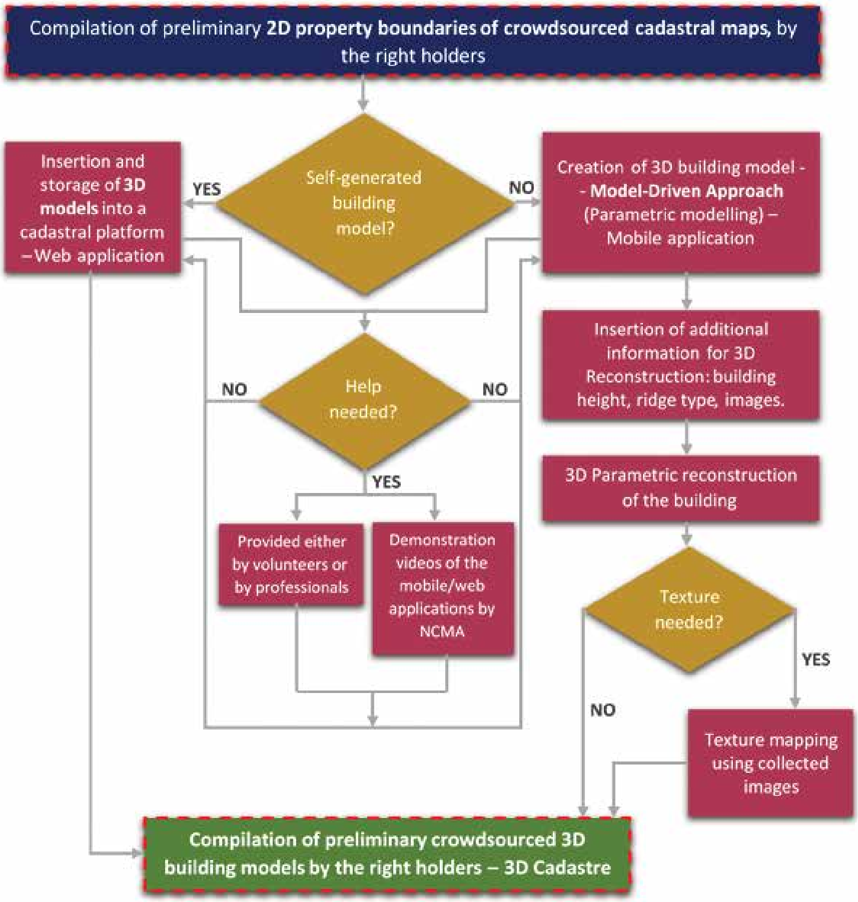

Figure 9: Phase 2 of the proposed framework for the implementation of 3D crowd sourced Cadastre.

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The paper was presented at FIG Working Week 2017, Helsinki, Finland, 29 May - 2 June 2017.

Low cost GNSS and Geo-referencing

This paper presents challenges faced by surveyors in Jamaica to geo-reference small rural cadastral surveys. An interim solution to the problem is provided. We present here the second part of the paper. Part 1 was published in the September 2017 issue


Tomoye Allen
Bachelor of Sciences Degree, Surveying and Geographic Information Sciences, University of Technology, Jamaica


Ronaldo Brown
Bachelor of Sciences Degree, Surveying and Geographic Information Sciences, University of Technology, Jamaica


Amahl Hutchinson
Bachelor of Sciences Degree, Surveying and Geographic Information Sciences, University of Technology, Jamaica


Keith Wignall
Bachelor of Sciences Degree, Surveying and Geographic Information Sciences, University of Technology, Jamaica


Glendon G. Newsome
Senior Lecturer, University of Technology, Jamaica

Methodology

This study falls in the category of Applied Research, as it seeks to answer the question as to whether low cost GNSS receivers can be used to geo-reference small rural surveys. The methodology applied is quantitative, since the data collected is numerical and is used to produce statistical analyses.

Data Collection

Data was collected in both Autonomous and Static modes on known stations in the National Calibration Network of Jamaica, located at Heroes Park in Kingston. In autonomous mode, coordinates were recorded every five minutes (5mins) for at least thirty minutes (30mins).

The hand held receiver, was placed over the first station, and the coordinates recorded. It was then moved to the second station where the coordinates were recorded instantly and then allowed to log data for five minutes before a second set of coordinates was recorded. It was then moved back to the first station where the coordinates were recorded instantly.

After that the receiver was left alone for five more minutes before the coordinates were recorded again before taking it back to the second station to record the newly generated set of coordinates. For each set of coordinates that were recorded, the time of the recording was also noted. In static mode, the GPS receiver was centered over the mark for between twenty (20) and forty-five (45) minutes while data was being logged.

Data Processing

The Most Probable Value (MPV) and Standard Deviation (SD) of the coordinates were computed using the autonomous data, while the relevant proprietary GNSS software was used to perform the data processing and adjustment for the static data collected with each receiver. The coordinate and vector differences were then compared with the respective known points and lines.

Results

When the various receivers were used in Autonomous Mode the coordinate differences with reference to a known calibration point are as set out in the tables 1-3, while the vector differences for two (2) lines using a differential grade receiver are given in table 4.

When two of the receivers are used in Static Mode with an External Antenna, the coordinate differences after post processing with reference to a known VRS Station are as set out in the tables 5 and

Coordinate Differences		
Time(mins)	N(m)	E(m)
5	2.97	1.02
10	2.86	1.28
15	3.08	1.51
20	2.95	1.03
25	2.90	1.08
MPV	2.95	1.19
STD_DEV	+/- 0.08	+/-0.21

Table 1: Commercial Grade

Coordinate Differences		
Time(mins)	N (m)	E (m)
5	-0.32	2.16
10	-0.32	1.16
15	-1.32	5.16
20	-0.32	4.16
25	-1.32	6.16
30	-1.32	3.16
35	-1.32	6.16
40	-1.32	10.16
45	-1.32	5.16
50	-0.32	8.16
55	-0.32	6.16
MPV	-0.87	5.25
STD_DEV	+/-0.52	+/- 2.59

Table 2: Differential Grade

Coordinate Differences/Error		
Time(mins)	N(m)	E(m)
5	2.19	0.02
10	3.19	-1.98
15	3.19	0.02
20	2.19	-0.98
25	0.19	-2.98
30	0.19	-0.98
MPV	1.86	1.15
STD_DEV	+/- 1.36	+/- 1.16

Table 3: Single Frequency

Vector Differences					
Line	Degree	Min	Sec	Dist (m)	P/A
NC06-NC07 (66m)	0	48	38	-0.26	260
NC08-NC01 (99m)	0	3	26	-0.65	154

Table 4: Commercial Grade

Coordinate Differences		
Point	N(m)	E(m)
NC02	0.0202	-0.0065
NC06	0.1068	-0.0156
NC07	-0.0860	-0.0717
NC10	-0.0015	-0.0259

Table 5: Differential Grade
(Occupation time – 20 minutes)

Coordinate Difference		
Point	N(m)	E(m)
NC06	0.0222	-0.0074

Table 6: Single Frequency
(Occupation time – 45 minutes)

Vector Differences					
Line	Degree	Min	Sec	Dist (m)	P/A
NC06-NC07 (66m)	0	10	25	0.00	308952
NC08-NC01 (99m)	0	0	52	0.02	5016

Table 7: Differential Grade

6, while the orientation differences using differential grade are shown in table 7:

Analysis

Graphic displays of the coordinate differences or error, when the receivers are used in Autonomous Mode, are given in figures 1-3

The coordinate differences or error returned by the commercial grade receivers displays erratic behavior in the northing component, but a consistent sub 2m difference in the easting. For the purposes of the new regulations, such a receiver would be considered inaccurate by virtue of section 35D, subsection 3 of the Land Surveyors Act. A close examination of the data recorded in table 1, reveals that there are at least two outliers (10 m and 8 m). Should these be rejected, the standard deviation would be reduced to less than 2m. This would suggest that the average coordinate computed from the remainder of the dataset has a mean distribution (precision) of less than ±2m around that mean/MPV. However, what is of greater significance to the Land Surveyors Act, is that the instrument is capable of delivering a result within ±3 m of the true value i.e. accuracy. Even at a precision better than ±2 m, the accuracy is worse (+/- 0.88m, +/- 4.38m) than ±3 m in this case. However, the result of any GNSS survey is a function of conditions of the site, occupation time and most importantly the state of the constellation (PDOP) at the time of observation. It must also be borne in mind that the commercial grade and indeed some differential grade receivers may be GPS only.

Both the differential grade and the single frequency receivers deliver sub 3 m coordinate differences in autonomous mode, which suggest that they are ideally suited to geo-reference small rural cadastral surveys, in this mode based on the temporary exemption. However, it is the orientation of the survey which is a cause of concern given the 49' difference on a 66m line, since the directive requires that the North arrow be labeled Grid North. With antennas attached or engaged, both deliver sub 10cm coordinate differences (Tables 5 and 6) and less than 11' difference in orientation using post processed static data. This result supports the use of these receivers for geo-referencing not only rural surveys but also urban surveys.

Recommendations

Consideration should be given to the fact that single frequency receivers are limited in range by between 10 to 15km, and given the spacing of the VRS stations, not all locations would be within this range of a VRS station. Outside of this range, surveyors would need to have a second receiver for occupation of a nearby (within 15km) SMD_NLA ground control, which would work counter to the issue of cost. What is of concern to many surveyors is the need to do this for the majority of their rural surveys in very remote areas which are less than 2000 sq. m. where the basic cost of the survey is already a strain on their clients' meager budget. One thinking is that Surveyors should be allowed to use commercial grade GNSS on deep rural parcels less than 2 hectares.

The new regulations require that surveyors submit a completed reporting form, indicating the method of fixing the points and the quality of the coordinates submitted. In the case of autonomous occupations, it is therefore recommended that the points be occupied for a minimum of 45 minutes, in the form set out in table 1. This would allow for adequate redundancy and therefore the rejection of outliers for the purposes of computing an acceptable mean/mpv. The mean/mpv and standard deviation of the two (2) points occupied should be written on the plan.

Occupation should only be after proper mission planning is done to ascertain the predicted GPS/GNSS conditions at the site and therefore the best time to observe these coordinates. Of course the site selected must be the two best locations/stations, even if one has to be auxiliary (longest possible line) to the traverse being used to carry out the survey. Also, if surveyors will be allowed to use commercial grade receivers, unless there is evidence of marked improvement in their performance, say for example, they are GNSS and outputting sub 3 m in typical condition, their use should be a temporary measure, allowing surveyors adequate time to upgrade to at least differential receivers. This is principally because deriving the orientation of the survey from ±3 m coordinates results in a very weak determination of this component of the vector. While this continues to be the case surveyors are now required to place a note on their plan to say that: "The accuracy of the orientation is commensurate to that of the standard deviation of coordinates of the boundary points."

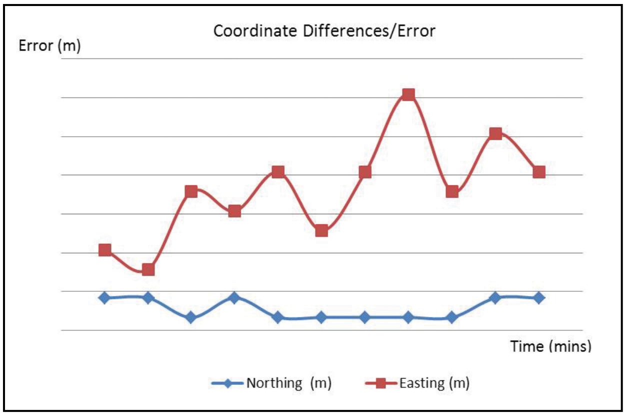

Figure 1: Commercial Grade

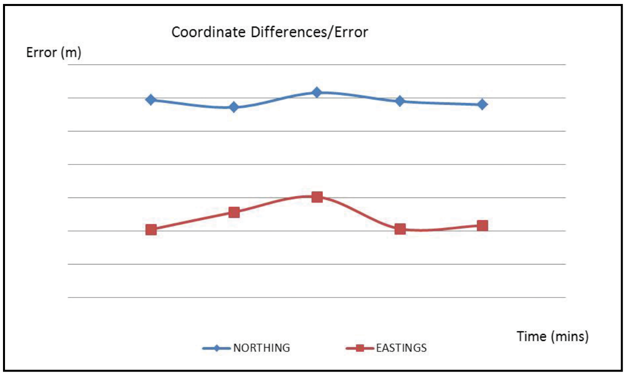

Figure 2: Differential Grade

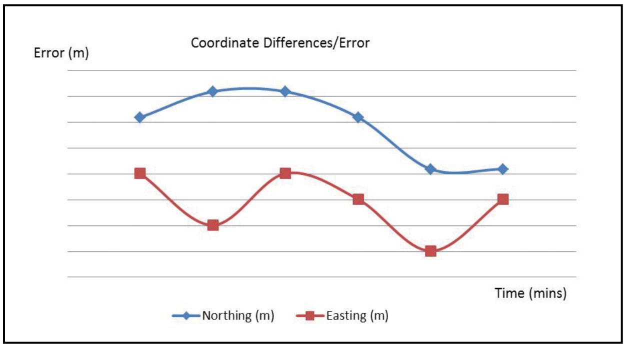

Figure 3: Single Frequency

Conclusion

All provisions for the use of low cost receivers for geo-referencing surveys in the rural areas will only apply where the survey falls outside the range of 400 m of a pair of SMD_NLA ground control or where VRS is not available. They are therefore expected to be temporary. While this continues to be the case and commercial grade receivers are used, we urge extreme care in arriving at the best solution for the mpv of the stations' coordinates by observing all best practices of GNSS surveys to obtain a standard deviation of less than ±2m. Differential grade and single frequency receivers have demonstrated that they are the better options suited for this task, if cost is a factor, and the surveyor does not envision his/her need to acquire dual frequency GNSS receivers, which would be at a cost outside of their budget.

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Who Moved My  Base?

PATENTS PENDING

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We will let you know instantly during your survey if your base has moved. We use:

1. Inclinometer which shows the tilt value.

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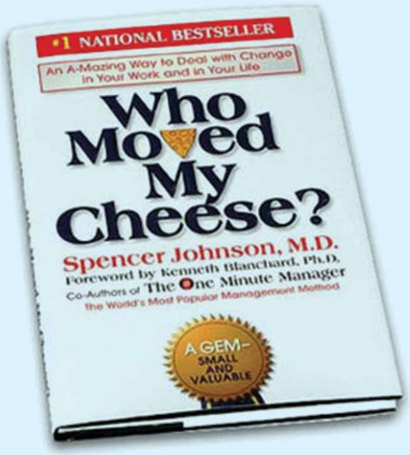
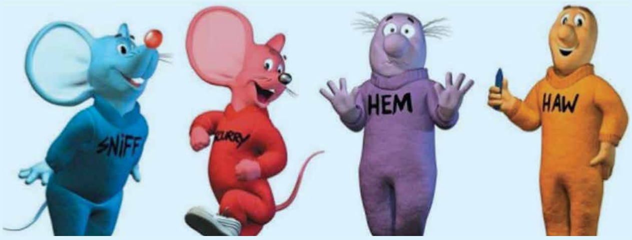


By the way, a must read book for adult professionals



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J-Tip advantages:

- J-Tip does not have “null” points around the peak and will not produce false alarms.
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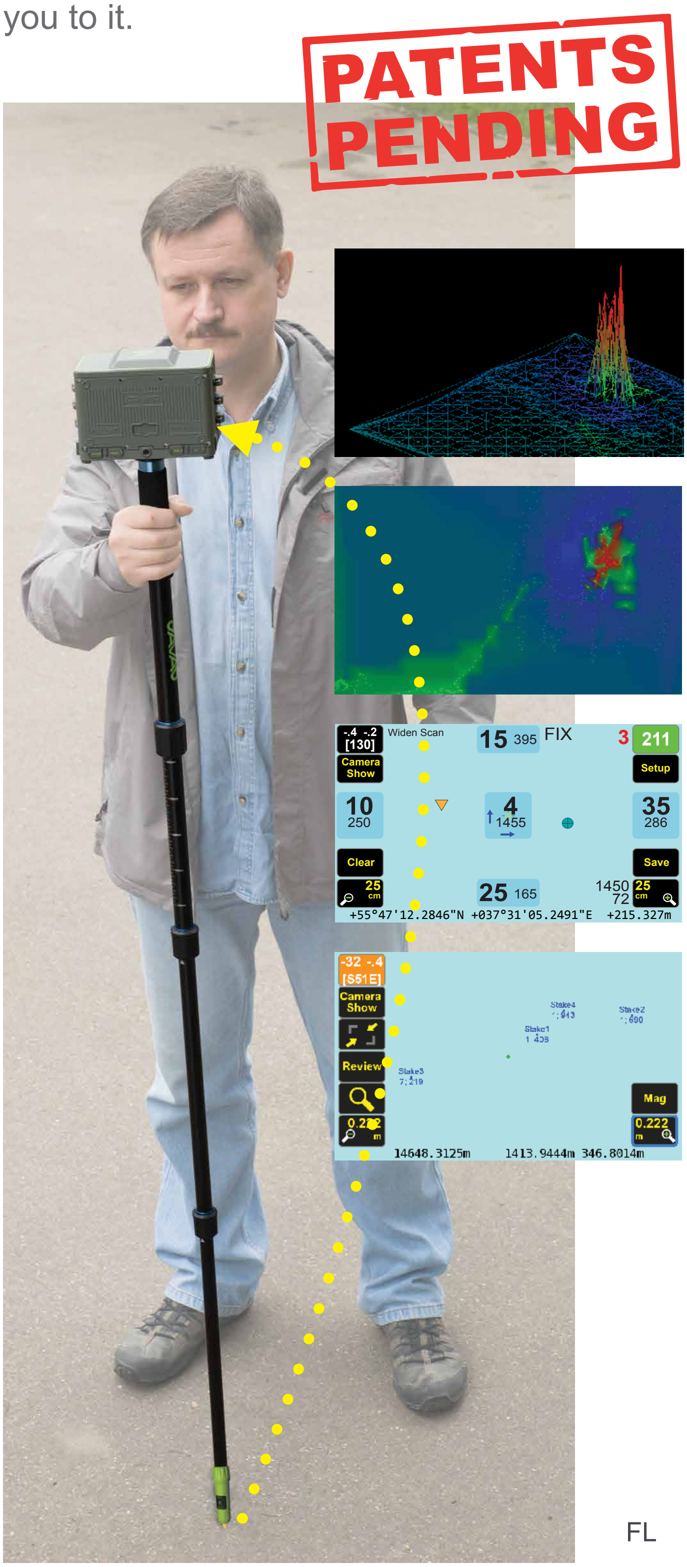
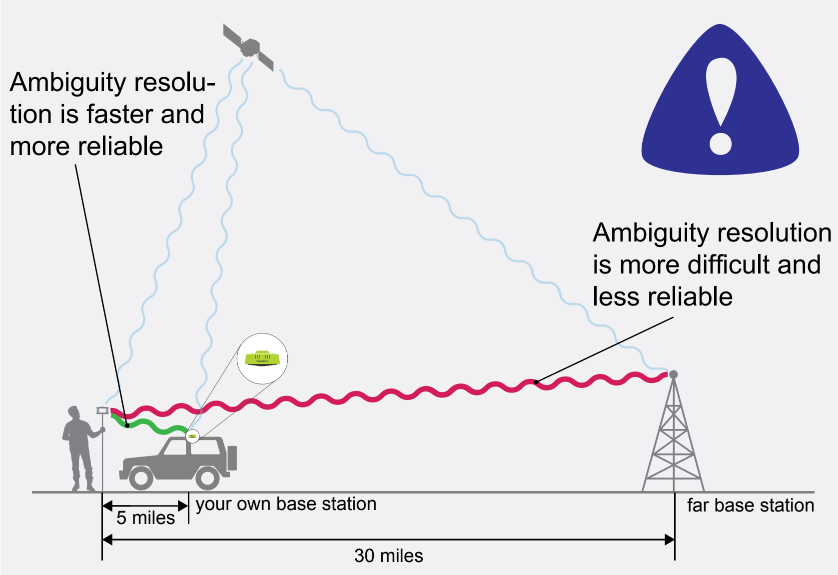
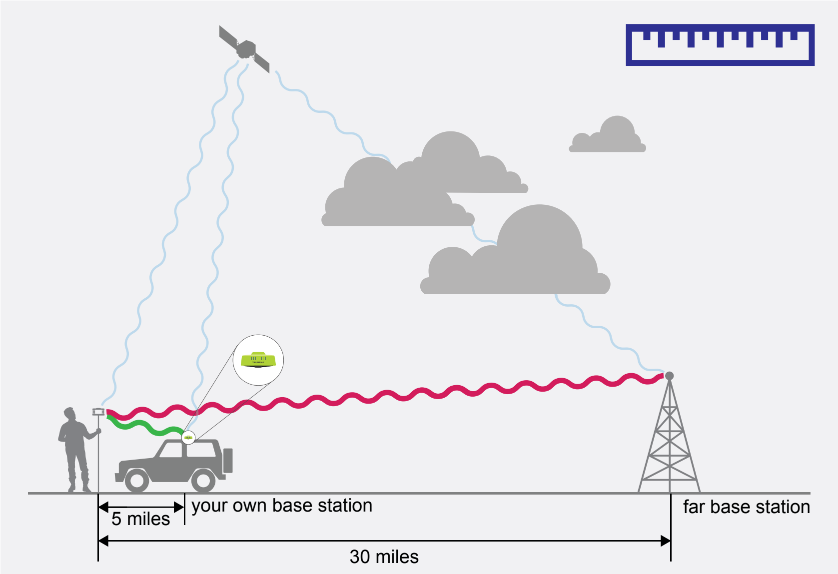
- J-Tip gives a 2D and 3D view of the field condition when you have RTK and will guide you to the object. You can actually see the shape of buried object.
- J-Tip, In Time View, shows positive and negative mag values of the last 100 seconds and the Min and the Max since Start.
- J-Tip shows the instantaneous magnetic vector in horizontal and vertical directions.
- J-Tip works as a remote control for the TRIUMPH-LS
- J-Tip weighs 120 grams and replaces the standard pole tip. In balance, it weighs almost nothing.
- The built in camera of the TRIUMPH-LS documents the evidence after digging.
- And... you don’t need to carry another bulky device.



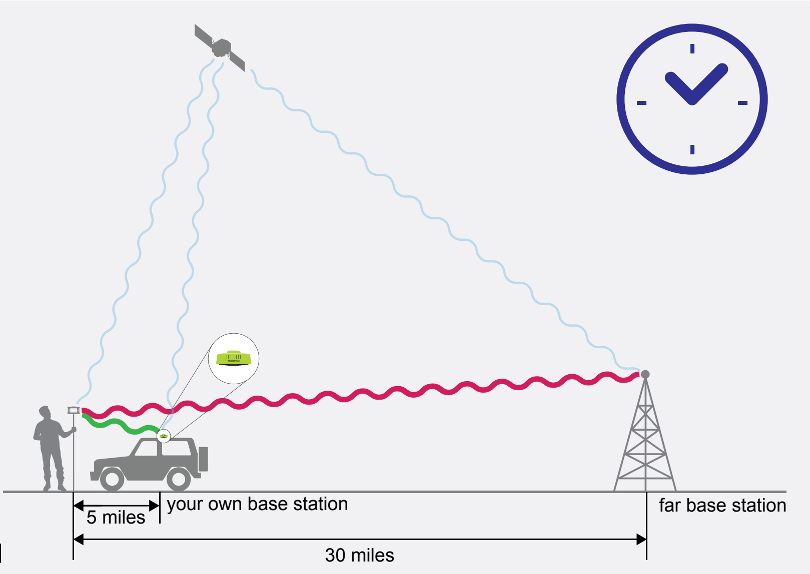
Advantages of your own base station...



1. Shorter baselines provide significantly better **reliability** because the ambiguities are much easier to resolve and the correct ambiguity solution has an obvious contrast.

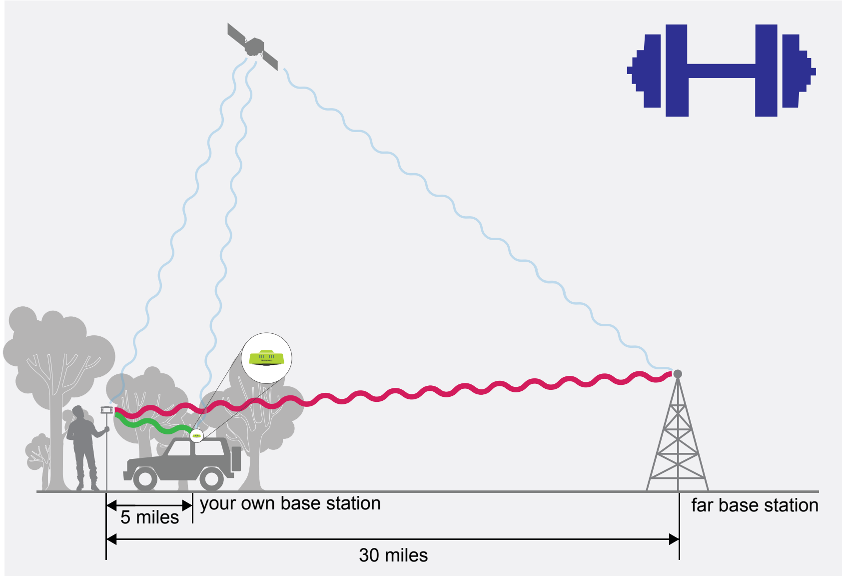


2. Shorter baseline has better **accuracy** because most of errors (like atmospheric and tropospheric effects) are common and cancel.

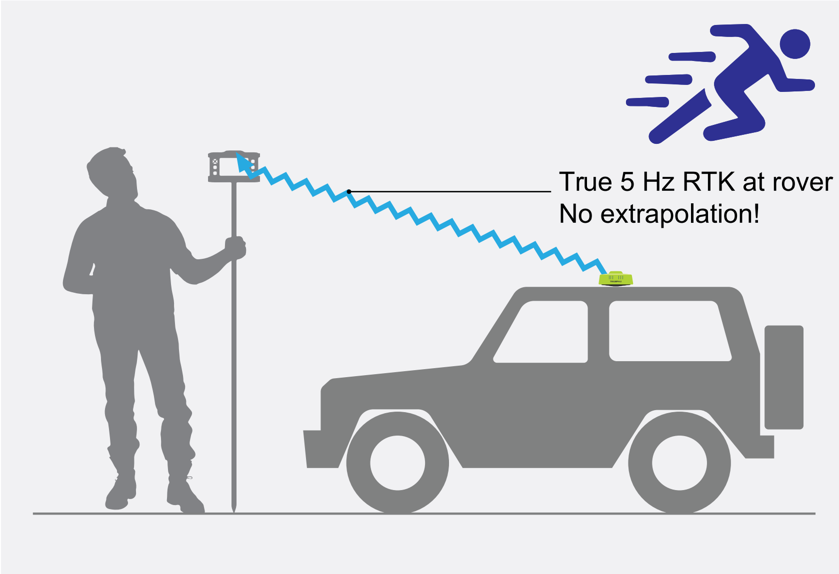


3. Shorter baseline ambiguities are resolved much **faster**. In longer baselines, incorrect ambiguities may pose as being correct in the statistical evaluations and it takes longer to isolate incorrect ambiguities.

4. Shorter baselines make it feasible to work in **difficult** areas (under tree canopy and in urban environments) because ambiguities have better contrast and are easier to resolve.

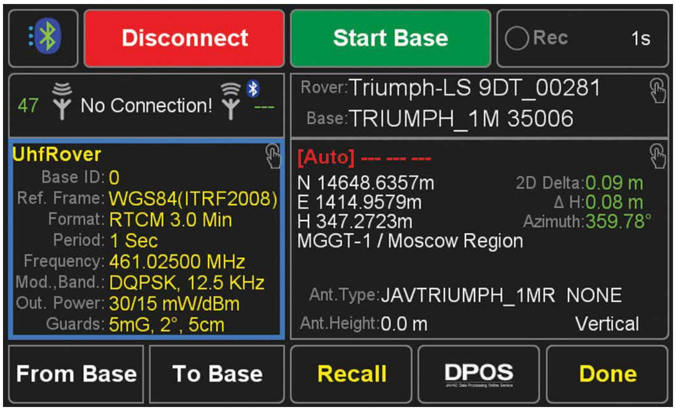


5. **Beast Mode RTK** is available only via our TRIUMPH-2 and TRIUMPH-1M base station. It makes ambiguity resolution up to 5 times faster because base station transmits base data 5 times per second. 5-Hz Beast Mode RTK is totally different from the up to 100-Hz RTK that is done by extrapolating the same 1-Hz data 100 times per second AFTER the ambiguities are fixed. This extrapolation technique does not improve the ambiguity resolution speed and is mainly used in applications like machine control after the ambiguities are fixed.

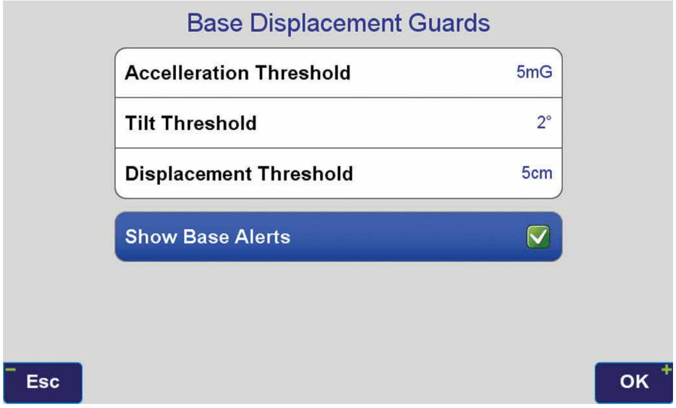


6. In addition to savings due to speed and reliability, it saves you RTN and communication charges. A complete system, Base + Rover + Radio + Controller & Controller Software, starts at $19,990. 0% financing available ($1,537.69 per month for 13 months) to active license US Professional Land Surveyors (PLS). Extended finance terms also available, contact sales@javad.com for details.

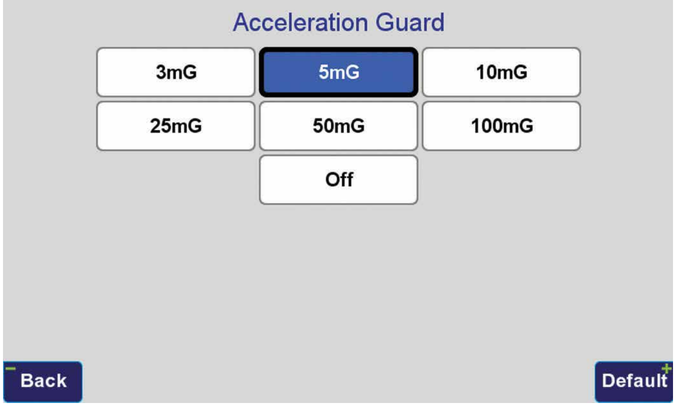
...and ensure that your base has not moved



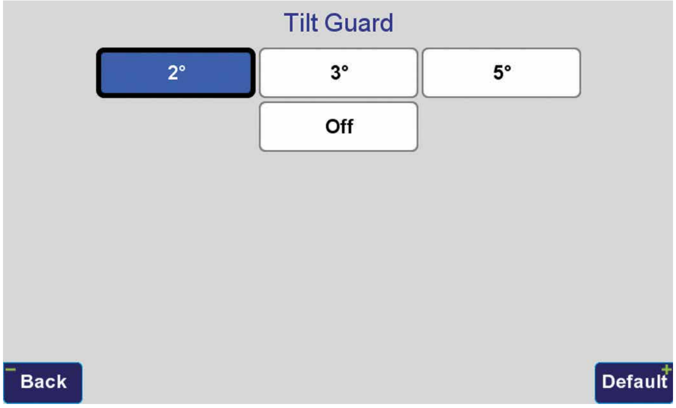
To setup for base movement alert, go to base rover setup screen and click on the left side of the screen



You can set up threshold limits for accelerometer, inclinometer (tilt) and displacement values to create alert when these thresholds are exceeded..

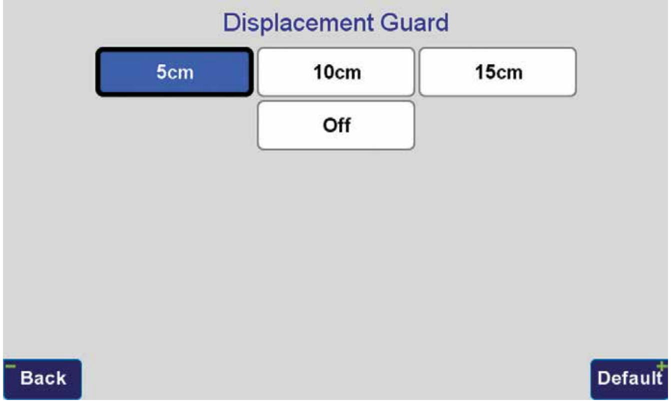


Set Acceleration limit here. The units are in milliG (mG). G is acceleration in free fall. “Off” means ignore this sensor.
Our default is 5 mG

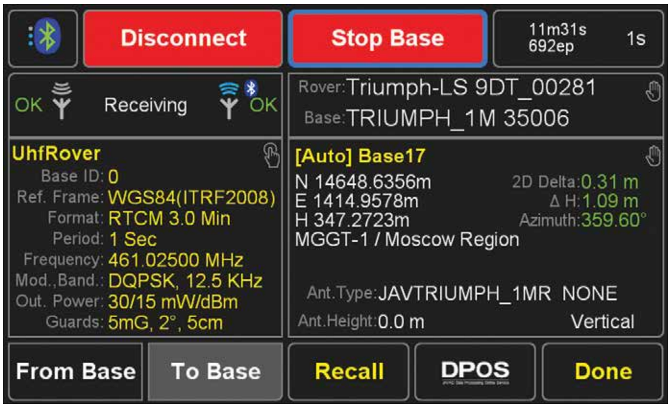


Set the tilt threshold here. Units are in degree. “Off” means ignore tilt.
Our default is 5 degrees.

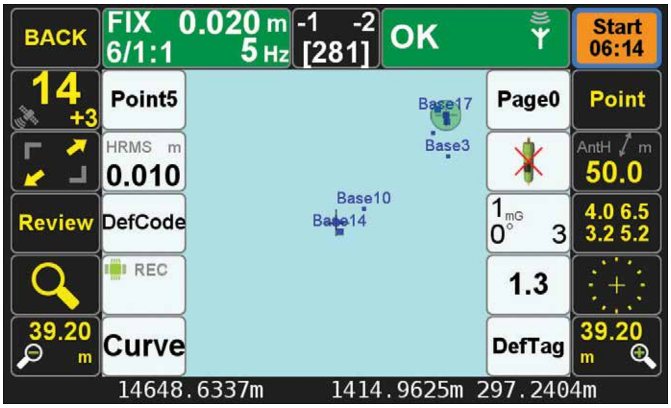
...or be alerted immediately if it did.



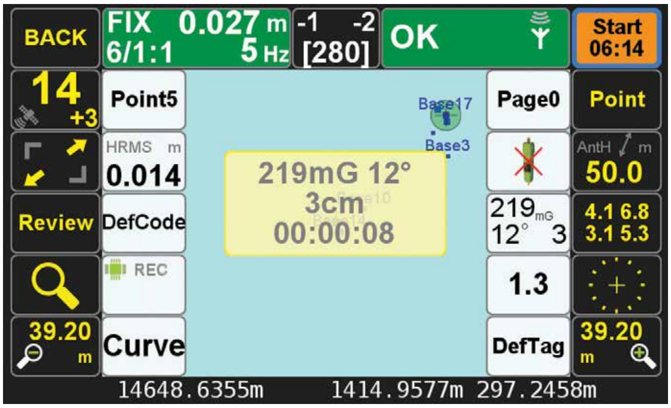
Set the displacement threshold here. “Off” means ignore displacement.
Our default is 5 cm.



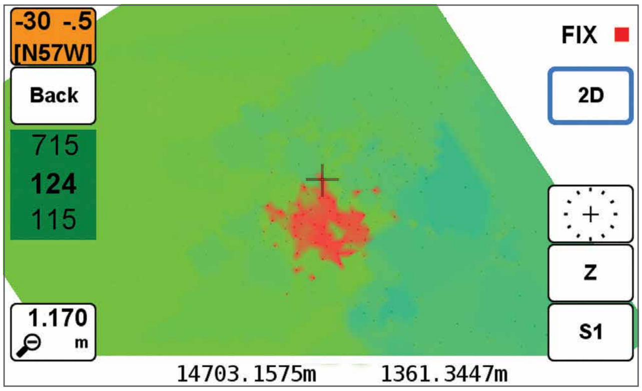
Click the “Start Base”. it will change to “Stop base.”
RTK corrections as well as motion values will be transmitted to the rover.
Maximum values of the motion parameters will be kept at all time.



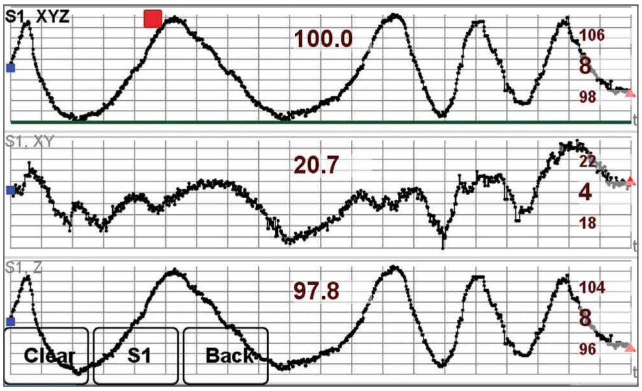
Maximum values of the three sensors can be shown in a white box in the action screen. Top left is the acceleration in milliG, bottom left is tilt and bottom right is displacement in centimeter.



If any of the threshold values exceeds, a pop up will alert you and shows the maximum value of the sensors since you started the base. The bottom number is time since the threshold(s) exceeded.



2D magnetic view of the field



Time view of magnetic variations

Unlike conventional magnetic detectors which sense magnetic values only in one direction, J-Tip has three dimensional magnetic sensors. You can view magnetic values in **XY** (horizontal), **Z** (vertical), and **XYZ** (combined) directions.

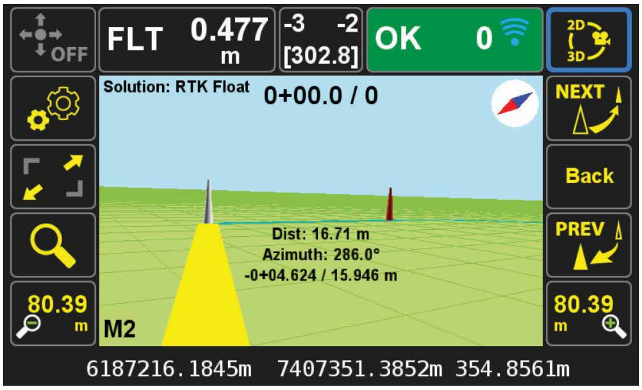
In addition to the audio notifications, J-Tip shows magnetic values in "**Time View**" (always), and in "**Spatial Views**" (**Mag**, **2D**, and **3D** views) when you have RTK solutions.

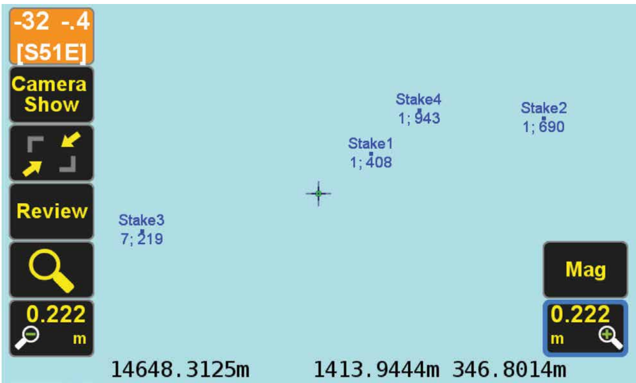
When you have fixed RTK, hold the monopod vertical (within 5 degrees) to tag mag values with their coordinates. J-Tip scans the area 100 times per second and stores the highest mag values and shows them in a large grid. In Spatial Views, the **graphs are centered on the cell with the highest mag value**. Only points that fit in the grid will be shown. The number of such points is shown above the progress bar. The "Clear" button restarts the process.

In Mag mode, pole tilts are corrected automatically and RTK is set to extrapolation mode.

The calculated coordinates of the object is shown in the bottom of the Mag screen.

Time graphs (above) show the magnetic values of the selected sensors in Z, XY and XYZ directions during the past 100 seconds. It also shows the Min and Max values since the Start/Rest. Click on any of the three graph component to expand it.





When you scan a large area, you can save all possible peak points, view them on the map and select the point with the highest peak to dig.

When you save a point, you can also save all the raw Mag sensor data for future view and research. We also plan to give you the ability to share that data with us by transferring it directly to our server for analysis and improvement.

We have not only integrated a sophisticated magnetic locator in the TRIUMPH-LS, but we have also streamlined the whole process. First the "Stakeout" screen will guide you toward the target.
Then the "Mag" screen locates your underground target and gives you its estimate of the coordinates of the underground target and a button to save it "as staked".
And finally in the "Collect" screen you can survey the target point which you have dug up and exposed. This is also the time to use the built in camera of the TRIUMPH-LS to photograph and fully document the evidence which you have recovered.

TRIUMPH-1M

864 channel chip, equipped with the internal 4G/LTE/3G card, easy accessible microSD and microSIM cards, includes “Lift & Tilt” technology.

TRIUMPH-2

Total 216 channels: all-in-view (GPS L1/L2, GLONASS L1/L2, SBAS L1) integrated receiver.

The one and the only Digital Radio Transceiver in the world!

Unique adaptive digital signal processing, which has benefits: the full UHF frequency range and all channel bandwidths worldwide • the best sensitivity, dynamic range, and the highest radio link data throughput • embedded interference scanner and analyzer • compatibility with another protocols. Cable free Bluetooth connectivity with GNSS receivers and Internet RTN/VRS access via embedded LAN, Wi-Fi, and 3.5G

And all this with competitive prices!

HPT435BT/HPT135BT/HPT225BT*

35 W UHF/VHF Transceiver

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4 W UHF/VHF Transceiver

HPT401BT/HPT101BT/HPT201BT*

1 W UHF/VHF with internal battery

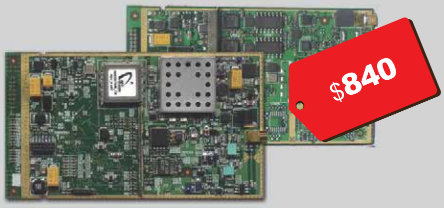
L-Band/Beacon*

Receivers for multiple applications

JLink 3G LTE BAT*

Web-interface Wi-Fi, Ethernet, 3.5 G, UHF/VHF/FH915, internal battery

OEM Solutions



902-928, 360-470, 225-255, 138-174 MHz

*Power, data cables and antenna are included.

Back

Development of inverse pedagogy through the implementation of a wireless response system

Lessons learned from the Geomatics course

Daniel Paez
Universidad de los Andes
Bogotá
Colombia

Luis Rubio
Universidad de los Andes
Bogotá
Colombia

This article describes and evaluates the performance of two undergraduate student classes taking the Geomatics course at Universidad de los Andes. Geomatics is a science that studies geographic data collection and analysis, which has traditionally been an area of engineering and its teaching, has been through Cathedra and hands-on experiences. In general terms, Geomatics is an introductory course for engineers such as civil, environmental, and transportation, and for other areas such as, geography, architecture and urban planning. Geomatics courses are also basic courses in topography, cadastral engineering and Geodesic engineering, where it is delivered, not only at an introductory level, but also advanced.

Chart 1 shows examples around the world of Geomatics courses

In the case of Universidad de los Andes, the Geomatics course is mandatory in the Civil Engineering and Environmental Engineering curriculums, and elective in the basic cycle of the rest of the engineering programs. Currently, an average semester has 90 students in each section and an hourly intensity of 3 lecture hours and 3 practice hours per week, for 15 weeks.

Information and Communication Technologies (TIC, for its acronym in Spanish) are being increasingly used in teaching to promote autonomous learning through the incorporation of digital technology. As per Cabrero (2006), TICs configure new training environments and scenarios with relevant characteristics.

The use of technology in the classroom has been proven to improve pedagogy in matters such as guidance and tutoring, they bring down space-time barriers, ease collaborative work, and promote interactivity and flexibility in learning.

The inclusion of technologies in everyday life has an increasing impact in this century, thus education must adapt to new changes within a more globalized society, which is marked by the presence of communication technologies (Cabrero & Aguaded, 2003).

Even though there have been previous investigations to encourage the benefits of these technologies, (Reay, 2001; Rooney, 2003; Sands, 2002; Ward & LaBranche, 2003; Young, 2002; Osorio, 2010), the effectiveness in engineering courses with a high technological content, and taught to large groups (over 50 students) is still unknown.

Specifically, this research focuses on quantifying the impact of the use of videos

University	Country	Name
U. de los Andes	Colombia	Geomatics 1
Melbourne University	Australia	Mapping envioronments
Oregon Unversity	USA	Control Surveying

Chart 1. Goematics Introductory Courses

for operating devices (instead of classroom demonstrations) and the use of clickers or technologies that allow for electronic participation in class. The use of these two technologies has the purpose of improving class participation and encourages the students to learn the materials by themselves outside the classroom, in order to implement a reverse pedagogy.

This article is divided into 3 parts. The first part presents the methodology used, including the tests used for assessment. The second part shows the case study and the results achieved. Finally, conclusions and recommendations for further research are presented.

Materials and Methods

Based on a pedagogical review of the Geomatics course, carried out by the education research group of Universidad de los Andes (conectate.uniandes.edu.co), it was found that the Geomatics course presented important characteristics to implement technology in education. Specifically, it was found that the size of the attending group (over 90 students) provided an opportunity to seek for alternatives to improve pedagogy in a large engineering course.

The decision to use this technological tool in the faculty of engineering was made based on the inconformity of the students with the lecture classes and the reduced motivation the students had to prepare the classes.

Likewise, the desire to implement educational enhancements to improve student and teacher performance at Universidad de los Andes, supported this research in the conectate.uniandes.edu.co group.

As previously stated, due to the conditions of the Geomatics course, student participation becomes difficult as a result of the theater-shaped classroom infrastructure and the size of the group (over 90 students per section). Also, using the various current pedagogical alternatives, two technological actions were drafted: material virtualization and the use of clickers

Regarding virtualization, we implemented playing back some introductory videos for the use of topographic devices, shown in class (altimetry level, total station and GPS). This pedagogic methodology is different from the previous lecture style classes, since, the teacher usually gathered the students outside the classroom and made a demonstration.

These videos were filmed with Professor Daniel Páez and had a carefully edited script to prevent missing functional concepts that were important for the students. Average video duration was 5 minutes while demonstrations took over 45 minutes.

Regarding clickers, the use of Learning Catalytics in the Geomatics course was provided, which is a commercial product created at Harvard University by Eric Mazur, Gary King, and Brian Lukoff. This software was purchased by Pearson in 2013 and used around the world since then, with results such as the development of critical thinking and communication skills.

In order to assess the effect of these two methodologies in this research, a control group was designed, in which the standard pedagogical methods were used (hereinafter Section A), and another group, where both technological methodologies were implemented (hereinafter Section B).

In order to ensure that both sections had students with the same academic capabilities, the averages of all students were requested from the department, finding them similar, ranging from 3.6 to 3.8 for the semester in which the study took place.

As strategies to isolate the effects of the use of virtualization and clickers, the following was considered:

- The contents or class themes to be covered should be exactly the same in both sections.
- Tests, as well as their weight in the students' final scores also had to be exactly the same.
- Tests were administered at the same time and under the same conditions for both groups.
- Students in each section were not aware of the differences in the pedagogies used.

From the investigative standpoint, the effectiveness of the use of technologies consisted of comparing the numerical results in the academic tests.

The course is divided into 5 modules, and assessed through lab practices, tests, and a final project. 3 tests were administered throughout the semester, as is usual for each course, to produce individual scores for each student, whereas the rest of the assessments are by group. The 2 first tests were non-cumulative and evaluated half of each module, while the third test evaluated everything covered during the semester.

Also, surveys were completed to determine student perception about the use of the pedagogical methodologies used in each group.

The survey given to the students asked about specific learning activities. These were based on prior experiences from literature (Conole, 2007; Marcelo, Yot & al., 2014), and covered aspects such as: satisfaction, interactive class, commitment and learning perception.

The evaluation scale of the survey was divided in 3 categories: Completely Agree, Neither Agree or Disagree, and Completely Disagree.

Results

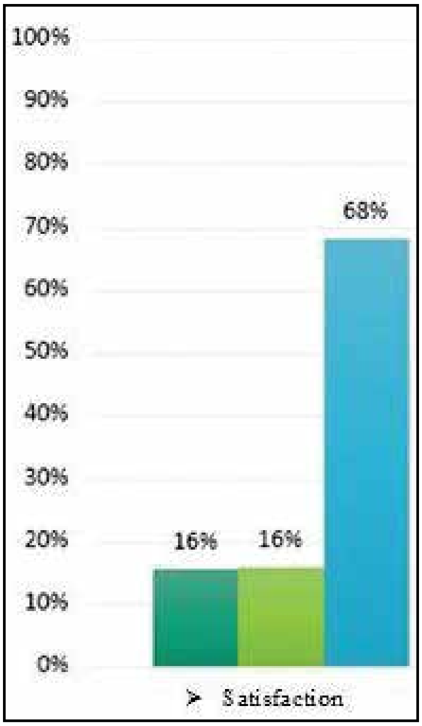
Comparing the Geomatics scores of both sections, shown in Chart 2, the average grades for the first two partial tests are very similar.

	Section A	Section B
Partial Test 1	3.07	3.12
Partial Test 2	3.65	3.67
Partial Test 3	3.50	3.08

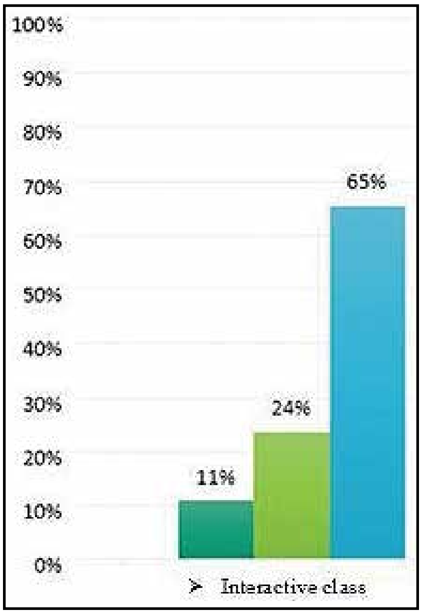
Chart 2. Average scores of the partial tests taken by both sections

However, the performance of those students who used the Learning Catalitycs tool throughout the semester displayed a 15% improvement when compared to those who did not use it.

Specifically for the subjects assessed, there were differences, with higher

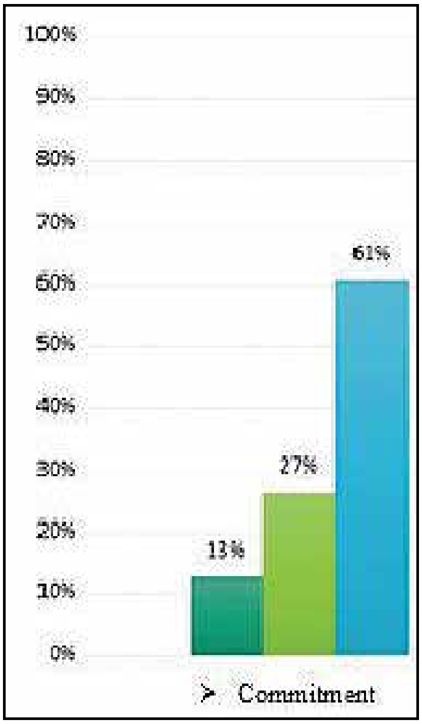


Graph 1. Survey results for the satisfaction component

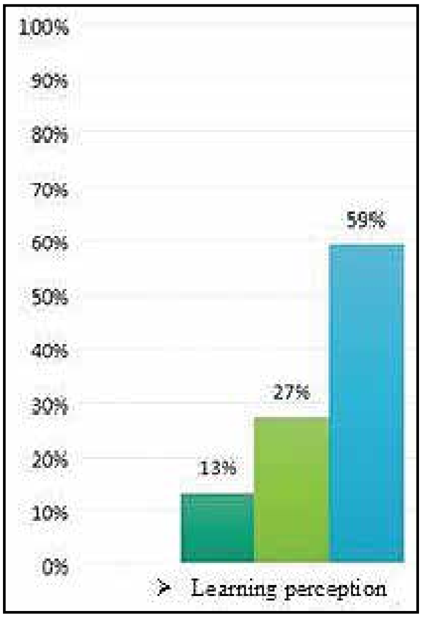


Graph 2. Survey results for the interactive class component

differences in planimetry and altimetry. For the subjects of geographic information, the results suggest there was not a significant contribution. This is due to the video virtualization on how to set up and measure, using the topographic devices of the first part of the course, which were planimetry and altimetry.



Graph 3. Survey results for the commitment component



Graph 4. Survey results for the learning perception component

Surveys applied to the students who used the technological tools show that 68% of the students fully agree with the evaluation of the 4 factors, as shown in the following graphs.

Graph 1 shows that more than half of the course significantly embraces the tool. There is a high percentage of satisfaction as a response to the implementation of Learning Catalitycs.

Similar to the answer for the satisfaction component, class interactivity increased by over 50%. This is due to the fact that Learning Catalitycs allows the instructor to ask the group quick text, graph, or even mathematical questions that the student must answer immediately and the teacher receives the results in real time. This encourages the student to prepare their class, since they will receive bonus points and the class becomes a more educational environment.

In this part, student commitment increases due to the motivation felt for the class. Innovation with this sort of tool focuses on the student's attention and encourages engagement and responsibility.

Summarizing, the survey applied to the students that used technology, showed a considerable percentage, 63%, who stated that the use of Learning Catalytics aided in having a more interactive class.

The students also considered that the class time was more fruitfully used, due to the friendly interface of the program and they would like to see it implemented in more classes.

Figure 1 shows a summary of the survey results in each of the assessed aspects.

When the students were asked about the advantages obtained while using the tools, it was found that technical failures are the main weaknesses of the methodology.

Disorder, loss of time with the tool and the teacher experiencing problems when operating the tool, were also identified as weaknesses for the use of clicker technology.

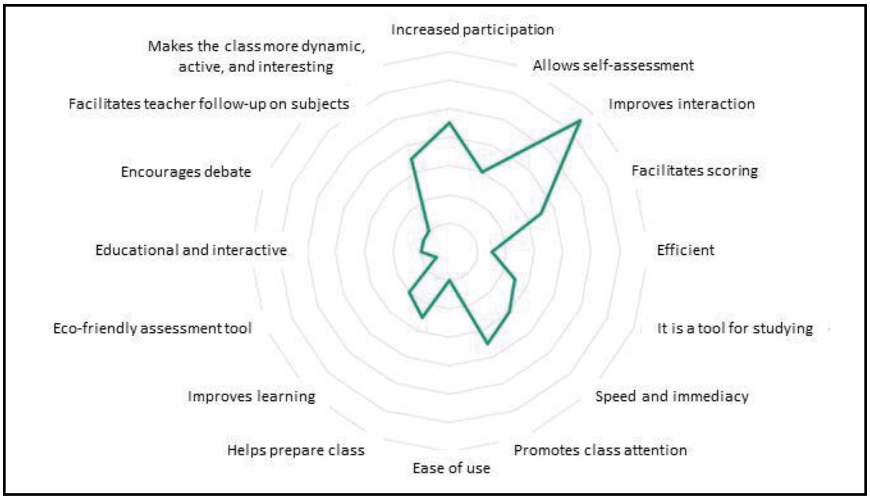


Figure 1. Perceived strengths

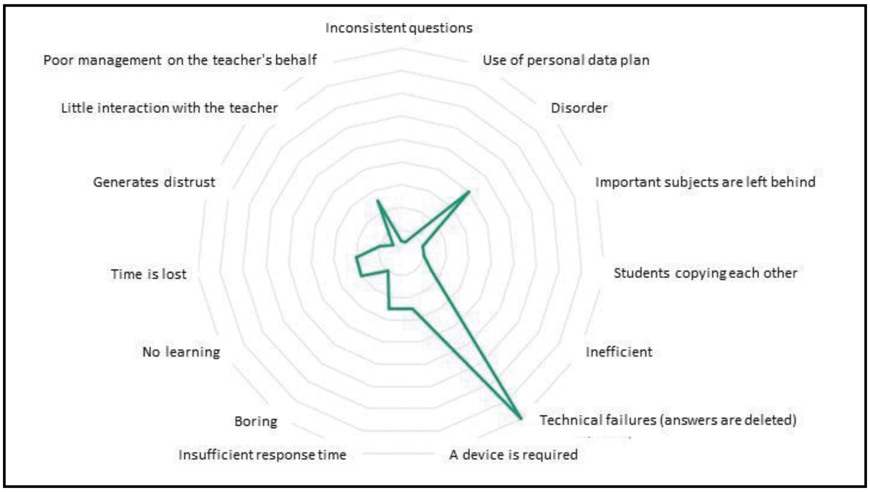


Figure 2. Disadvantages

Figure 2 shows a summary of the results of the survey regarding difficulties.

Conclusions

The study shows that the use of TC tools enables self-learning and promotes interactivity with the teacher in large sized classes. Likewise, Learning Catalytics is a user friendly tool that enables variety and a wealth of learning activities that few tools offer.

In order to use the Learning Catalytics, preparation is required regarding the questions that may contribute, to a larger extent, to a learning environment, in the short time that they are applied. Logistical challenges are inevitable when performing trials; however, once they are solved, it contributes to a reverse pedagogy.

Even though the tool does not generate a significant increase in test scores, it has many other positive effects such as: interaction with the teacher, increase in class engagement, and greater participation. .

Finally, research based on massive stored information on different means, will bring along the key to determine how to approach teaching in a new era, and therefore, it is important to encourage the use of processes and techniques related to data analysis, such as "Learning Analytics", because it offers the possibility to define an angle towards improvement, while strengthening the individual learning process.

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Modern quality assessments for control points measurements and calculations

This paper addresses the quality assessments process for control points measurements regulated by the Survey Regulations 2016 published by Survey of Israel. The paper will describe the workflow and documentation between the surveyors work in the field and the authorization process at the Survey of Israel Geodesy Division

Omer Bar
Geodetic Networks & Infrastructure Geodesy Division - Survey of Israel, Israel

Yuri Roy
Project management Survey of Israel, Israel

The Survey of Israel (SOI) conducts nation-wide geodetic monitoring and check-ups of all measurements conducted for numerous public interests. Each measurement, processing, adjustment and calculations upon them, is reviewed and authorized by SOI. In order to achieve an accurate and reliable statistical precision, each measurement project must be double-checked using a different set of tools used by the surveyor.

The regulations set by SOI, created guidelines for the surveyors in manner of how to measure in the field and how submit the measurements. Technological improvements in measurement equipment and in office-processing applications, the amount of data sent for authentication grew. Thus, regulated process of measuring, submitting and communications is established between the surveyors and SOI.

To help the surveyors keep organized with the numerous steps of authorization a technological web solution created for the surveyors and SOI reviewer as well. TOPOCAD, web based portal for the surveyor to communicate with the SOI reviewers for each measurement or cadaster project. TOPOCAD have numerous processes for simple regulatory tests to check if the data submitted meets the regulatory minimal criteria for each project. After these tests achieve a positive state, a reviewer will receive the project for a full review.

This paper addresses namely the process of control-points measurement quality assessment (QA). The process yields stable statistical tests, relying on normal probability distribution functions.

Reviewers at SOI have numerous validation tests and crosschecks for each project submitted for authorization. TOPOCAD, a new web based service dedicated for surveyors, helps the surveyors and reviewers to easily access and monitor the projects and authorization versus numerous surveyors.

Review

The Survey of Israel (SOI) is the national institute for geodesy, cadaster and geo-information in Israel, and is the regulatory authority for these issues combined. The regulations for land surveying, mapping and cadaster updated during 2016 [1]. Surveyors that carry out a project for public needs or public issues must meet the regulatory standards in-order to receive an authorization to use the mapping products.

Current Israeli regulation, supported with binding complimentary technical guidelines, dictate the process of measurement, process and adjustment needed to achieve sufficient accuracy (or accuracy ranking index / orders). The regulations determine which points "accuracy-class" (used for ranking index / orders) are measured by GNSS and/

or Total Station (TS). Each measuring type has unique binding guidelines describing the measuring method and relative process characteristics values.

The guidelines to measurement, processing and calculation of control point with GNSS instrument, describes set of criteria and values to obtaining 2D and 3D positions for measured control points. The guidelines try to set the path for the surveyor to achieve the best stable solution for the control point's position. The fieldwork mainly relies on the regulations itself. The regulations set the minimal and maximal measured parameters, such as edge length, for a specific accuracy ranking index (order) and the maximal error allowed while processing the measurements (for length miss closure and angular miss closure). Vertical index ranking (orders) are separated from the Horizontal index ranking (orders), thus special guidelines for measuring control points with elevation value.

Nation-wide control points with high accuracy are spread along the country as equally as possible, in order to help the surveyors work in the field. The 3D (position and elevation) control points that assemble the G1 & G2 accuracy ranking index (orders) were built and processed and calculated with numerous constrains, thus creating a solid bedrock for surveyors to base on. The 2016 surveying regulations and guidelines set the accuracy rank index (or order) for each new measured control point, based on: (1) the accuracy of the solution, (2) base point accuracy rank index (or order), and (3) tie/check control point accuracy rank index (or order). The surveyor uses the tie/check control point to test the validity of the entire project, by comparing the new measured position with the known position. Thus, creating a validation for the entire project and not only the processing of the control points.

Working methodology and addressing issues

A reviewer checks each measurement project submitted by a surveyor to the Survey of Israel. Each measurement project, prior authorization, tested for all of its components (1) measurements, (2) processing, (3) adjustment and calculations, (4) field mark or monument and its identification, (5) additional needed forms as "Control Point Identification and Description Form", which helps find the control point at the field containing information about its relative location with its surroundings.

Each reviewer uses a different set of tools that used by the surveyor, to create a statistical stable check. If all regulatory minimal guidelines are met, the reviewer re-calculates the entire project.

Control points computed from traverse measured by TS via Least Square (LS) Adjustment and with a minimal amount of base control points. The LS process yields 2D error ellipses or 3D error ellipsoids. Regulations stated that each traverse must consists of 2 initial known control points and a different set of 2 known control points at the end. Thus, the traverse must converge to itself. The regulations dictate what maximal length of traverse for each ranking index, and what the maximal miss-closure as well.

In order to achieve maximal compatibility between projects of different surveyors, Survey of Israel maintains and distributes official values to calculate the transformations between local measurement datum (IGD-05/12, intermediate datum which describes the Israeli Geodetic Datum 2005 – modified at 2012) to the Israeli working grid IG05. Additionally, Survey of Israel maintains and distributes an undulation model to preform transformation between ellipsoidal heights and elevations above sea level (orthometric heights) [2].

Vertical control points measured by Leveler

Vertical control points (or 1D control-points) are measured by means of a leveler and a level staff (or a set of two rulers). As a first validation of the measurement, all equipment must have a calibration certificate (of a certified calibration laboratory), specially the staffs. If calibrations exceeds the dated marks, a new calibration is in order or measurement projects submitted using these (full or partial measuring equipment) would automatically be denied.

Leveling measurement must be conducted carefully, following their specific guidelines. Thus, checking the calibration of the measuring instrument is crucial. Calibration tests and validation will be carried out at the beginning of each measurement day, and at its end. Usually, measurement cannot be completed at a single day of fieldwork – meaning a precise and detailed documentation of the measurement is in need. In-order to achieve optimal range of random error, leveler reading must be taken from a point as near as possible to the mid-range between the rulers.

For optimal validation of leveling project, the measurement must be between two sets of known control points or carried out as a loop. Meaning, closure checks can be tested 4 times (between these four known control points). For large areas projects a leveling network is advised, while four tie/check control points are spread evenly at the edges of the project area. Error detection in these case optimally carried out using a conditional LS adjustment. The conditions used for this LS process are the loop closures and closures between the known control points. The errors in this case could be derived directly by the vector of errors (v) from the LS adjustment process, seen in Equation 1.

Control points measured by TS

The regulations and guidelines set the maximal error allowed for a single control point to be measured by TS and the proper way to measure the control point. Nonetheless, guidelines set the maximal and minimal relations between edge size and traverse-internal-angles (left-facing angles) that support these accuracies, thus obtaining certain accuracy rank index (or order). The regulation state, for each ranking index (or order), the appropriate basis control points ranking index and what is the maximal expected miss-closures should be.

While measuring a traverse at the field, minimal Quality Control (QC) is in need. Checking for minimal internal angular miss-closure per site (on every TS post on a control point), and double check for distances between measured control points. These, QC checks and tests help the surveyor measure the traverse as efficiently as possible.

$$B = \frac{\partial F}{\partial l};$$

dreviative of independent leveling loops and lines by the measurments

w-missclosure vector (derived from independent loops and lines measured) P-Weight matrix (relies on distance and / or leveler positions

$$M = B * P^{-1} * B^{T}$$
$$v = -P^{-1} * B^{T} * M^{-1} * w$$
$$\hat{\sigma}^{2} = \frac{v^{T} * P * v}{degree\_of\_freedom}$$

Equation *1: Conditional LS adjustment for Leveling and Traverse*

For the conditional LS adjustment, the angular miss-closure (based on azimuth miss-closure) described by Equation 2. The miss-closure of easting and northing values described by Equation 3.

$$\alpha_0 + \sum_{i=1}^{k} \gamma_i - 180° * k - \alpha_k = 0$$

Equation *2 : Angluar miss-closure for Traverse Conditional LS Adjustment*

$$\left(N_i + \sum_{i=1}^{k-1} L_i * \cos a_i\right) - N_k = 0$$
$$\left(E_i + \sum_{i=1}^{k-1} L_i * \sin a_i\right) - E_k = 0$$

Equation *3: Easting and Northing miss-closures for Conditional LS Adjustment*

Conditional LS adjustment preformed on the measurement helps greatly in detecting gross errors, and assessing the 2D error ellipses (3D error ellipses) per control point. The traditional conditional LS adjustment is required for both horizontal and 3D traverses, thus the heights calculated from the trigonometric leveling traverse can be adopted ,as close as possible, as a leveled segment in a leveling network.

For basic cadastral uses, traverse based upon two sets of control points measured by GNSS (see chapter: Control Points measured by GNSS). Thus, the two measuring techniques are connected when calculating the error expansion for the control points measured.

Control points measured by GNSS

Control points (2D and 3D control points) derived from GNSS measurements via several methods of measurements:

(1) Post Processing

Post processing GNSS data carried out via several techniques:

(i) Base-Rover (single edge vectors only)

Note: the base can be one of the following options

(a) "G0 ranking" Permanent GNSS Stations (PGS) network (CORS operated by SOI),

(b) "S0 ranking" Private PGS network (CORS operated by a civil constructor, usually a surveyor),

(c) Known control points as base,

(d) Virtual Reference Station (VRS) (derived by a PGS network, national or private).

(ii) Traverse (based on known control points).

(2) Real Time Kinematic – RTK

(a) Private RTK – rely on a temporal or permanent private base station, which broadcasts corrections for its rover/s,

(b) Network RTK – rely on PGS network, enabling to work with VRS, FKP (regional correction model) and other regional correction models.

Each GNSS measuring type consists with a single known control point measurement per field measurement day.

RTK solution check criteria rely on differences between two set of measurement sessions (180 "fix" epochs per control point, per session) to derive the ranking index (or order) with respect to the short-hand normal distribution function by a sample of two measurements in the population.

Post processing of GNSS data, has more data to handle (rather in RTK which all "processing" done at the field by the GNSS receiver); more data yields more testing criteria - thus has less stability in the solution checking process. The guidelines for measurement process and calculate control points via GNSS instrument describes optimal processing parameters, in order to achieve the most stable solution for the control point position.

Nonetheless, the guidelines register particularly the specific kind of solution needed for horizontal solution and for a vertical solution, depending on the maximal allowed distance from the base station. Once a surveyor measures new points outside the measurement criteria listed by the guidelines (which is carried out by surveyors), the guidelines require the surveyor to apply more time, or a different solution type for the measured vector – such as adding time to the measurement or solving a baseline as Fixed IonoFree solution instead of Fixed solution. The Fixed IonoFree solution is needed for measuring geodetic heights for control points, meaning the surveyor must use a dual-frequency antenna and receiver, which records and handle phases.

Geodetic height measurement, and calculating elevations above mean sea level, is feasible using a unified nationwide undulation model. The Israeli Undulation Model (ILUM) is a geometric height differences model, based on precise GPS benchmarks having (1) adjusted geodetic heights, and (2) precise leveled and loop-adjusted elevations. Using ILUM the surveyors can measure geodetic heights and adjust them in a network or traverse fashion, than calculate the appropriate undulation, adding these values yield an orthometric elevation for the measured control points. Nonetheless, unique guidelines for this purpose describe the minimal amount of time per session, and the maximal distance allowed for this measurement and calculation process. Thought needles to mention, the base control point and the tie/check control points, must consist of authorized geodetic height and/or leveled elevation.

The Quality Assessment (QA) process for post processing position solutions require a checklist for several parameters needed to obtain the most stable solution. The checklist is conducted by the values and parameters describes in the appropriate guideline (depends on the solution technique). After the basic checklist entry pass, a reviewer processes the entire job measured by the surveyor. The most general test for a normal statistical distribution, is the final-value test, the distance between the two mean solutions (from the surveyor and the reviewer) must be half the maximal allowed error [3] (per specific accuracy rank index / order) to obtain a certain accuracy rank index (order).

Furthermore, in order to create a standard

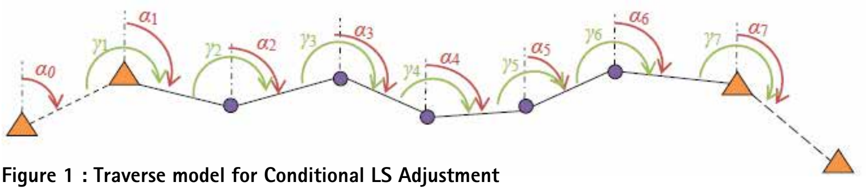

Figure 1 : Traverse model for Conditional LS Adjustment

QA process between the reviewers, readymade project-files (of processing software) with proper preferences (as stated by the guidelines) and spreadsheets tables for comparisons, are commonly used by all reviewers. Prior final position tests carried out, the reviewer tests if the session's solutions meet the minimal and maximal criteria per accuracy rank index (order), validation carried out by the calculating the distance between the two solutions (per control points).

The reviewer's solution is set to the guideline suggested processing values and a fix control point is set, if needed tempering with the satellites within the solution to ensure a good vector solution. After processing 2 sessions, and assuming all vectors have satisfactory error estimates, least square adjustment and calculating point position is carried out. Upon these solutions, the reviewer tests and sets the accuracy rank index (or order) for each point, by checking the geometric distance (horizontal and vertical, apart) between the solutions as can be seen in Equation 4.

Although the single edge post processing solution, as describes before, is a well-preferred fieldwork project type by most surveyors, the reviewers most certainly prefer the traverse project type. The traverse project type takes much more resources and relies on more than one GNSS receiver (and antenna). A vector network that uses two known control points as the base and the control. Using this method of surveying a full miss-closure report is created and it is much easier to detect error of measurement or processing. The LS process resembles the TS measurement, thus can be crosscheck using TS instrument (if line of sight is available).

An important tool for internal validation of a GNSS measurement project, crucial for GNSS vector networks and GNSS traverses is the Loop closure. Validation using loop closures test if the vector processing calculated variance-covariance matches the internal geometry created by all vectors closing a loop (or creating a flow between two known control points).

In the QA process, all error-estimations and positions of the control points calculated by both reviewer and surveyor should agree on same accuracy rank index (order). If this is not the case, the surveyor is addressed to accommodate this issue and a lower ranking index (or order) is acceptable or more measurement sessions are in order. If the reviewer is not certain that the solution is as stable as it should be, field surveyors from SOI can be sent to the field to validate some of the internal relations between the calculated control points – such as measuring the distance between sets of control points using TS instrument. The measured distance must be within the maximal error of the two control points measured, or will derive the accuracy rank index (or order) for these control points respectively.

Control points average location calculated by Surveyor- X_s, Y_s
error estimates calculated by Surveyor(order)- r_s
Control points average location calculated by Reviewer- X_r, Y_r
error estimates calculated by Reviewer(order)- r_r

$$if\ \sqrt{(\Delta X^2 + \Delta Y^2)} < \frac{max\_error\_per\_rank}{2}$$

$$if\ (r_s == r_r)$$

Final Position and Order ⇔ Calculated by Surveyor

Equation 4: *Validation Test Carried for a single Contol Point*

Private GNSS permanent network authorization

Currently, authorization of private PGS network is subjected to comprehensive validations at SOI, and is regulated under unique guidelines for establishing, maintaining and operating a private PGS network.

The validation of such network concludes: (1) visit to each station location for monument structure stability (preferably a monument to match the IGS guidelines for CORS monuments [4]); (2) three long static (24 hours) sessions; (3) LS adjustment with specific maximal accuracy (CEP at 95% confidence, 1cm horizontal and 2cm vertical). Each session must rely on all "G0 ranking" national PGS network (first order); with a full 3D fix on all their positions.

The post-processing of each session must consist with: (1) precise GNSS satellites orbits, (2) low data interval frequency processing (for lowering the noise in the vector processing solution) and, (3) sufficient elevation mask – usually preferred 15 degrees, lowering down to 12 degrees (same elevation mask is needed for all sessions).

The hardware used for receivers and antennas at each site must be with geodetic features, and must be reinforced to its physical base (rock, boulder, building etc.). Furthermore, tests carried out for signal to noise ratios (SNR) and Multipath using TEQC (UNAVCOs free RINEX utility). If values of these parameters exceed standard maxima, the position-adjusted errors will determine rather the site will be authorized or not (the L-band spectrum in Israel has relatively high noise due to high density of operating transmitting object, such as RADARs and microwave communication towers).

The reviewer, as in other projects, recalculates the sessions and preform network adjustment. Differences between the session's adjusted networks tested for maximal horizontal and vertical error per control point for validation. Finally, the separation between the two mean positions of the calculated, the distance must meet half the criteria listed in the specific guidelines [3].

Communication between the surveyor and Survey of Israel

TOPOCAD, a web based service to help the surveyors and the reviewers communicate, the service allows the surveyor handle his projects with respect to the regulations and accuracies demanded. TOPOCAD handles the full history of applicable forms sent by the surveyor and authorizations granted by SOI reviewers.

TOPOCAD creates an ordered working methodology, and helps the surveyor track the entire authorization needed for a specific type of project (cadastral, engineering etc.). TOPOCAD enables some cooperative relations between the surveyors, and any connected surveyors profiles; thus letting the collaborators, view partial or full information about each other's project.

Logging to TOPOCAD requires the surveyor have an active license and a chip for identification via card reader – meaning the connection is personal and is in the full reliability of the surveyor. TOPOCAD is part of sets of government websites, thus, assimilated in a government secured site.

Recent update from the Surveyor-General, parts of the entire geodetic database is fully free for surveyors and is accessible via TOPOCAD for the surveyors to use for planning, calculating and usage in their projects.Currently, TOPOCAD contains some useful applications, and the vision is to let the surveyors numerous tools to validate his work prior sending it for reviewing at SOI. In addition, reviewer would use fewer resources on default initial validations (required by the regulations) and more resources for geodetic, statistic and geometric validation tests. TOPOCAD encapsulates numerous data and information for the surveyors and enables quick access to it, as can be seen at Figure 2.

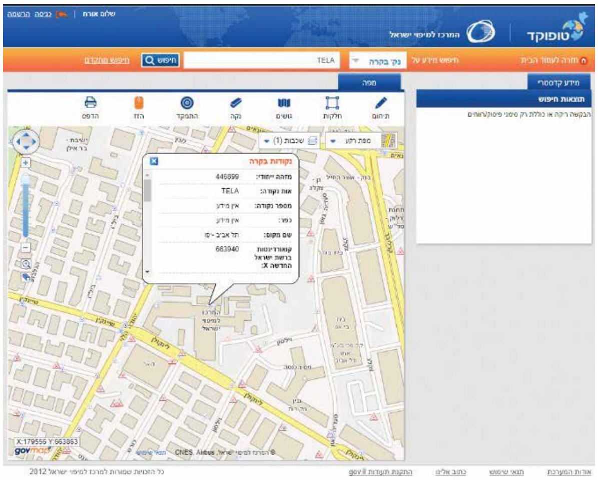

Figure 2 : TOPOCAD interface

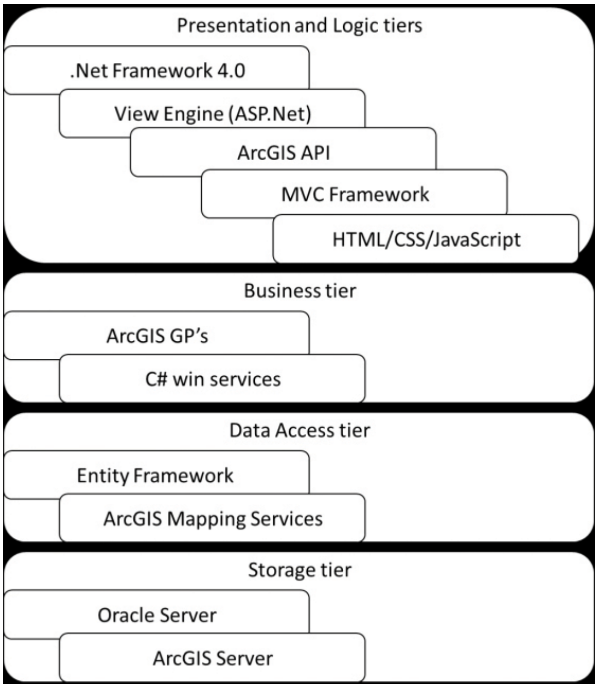

Figure 3: TOPOCAD architecture

Technological aspects

The Database (DB) implemented for TOPOCAD is a Relationship DB Managements System (RDBMS) by Oracle. The entire site and its services were coded in the following languages: (1) HTML, (2) JavaScript, (3) CSS, (4) ASP.Net, (5) C# (6) SQL and (7) PHP.

Geographic Engine for display and Geo-Processing (GP) is ArcGis from ESRI ltd. The Geographic and Geodetic DB is displayed using the ArcGis Server technology implemented by ESRI.

The ESRI geo-processing engine, implemented in the ArcGis server, enables a large set of geo-analyses and geo-statistics tools, in addition a large amount of algorithms such as "re-projection on the fly".

The TOPOCAD search engine is based on "Elastic Search" technology, meaning search will work faster and will perform its search logic of a big data search engine. The search engine have two modes: (1) free search and (2) modular search (search refined by the user). "Elastic Search" technology is capable of searching alphanumeric and geo data as well. The search engine is updated and re-indexed once a day for optimal resources usage.

TOPOCAD architecture

TOPOCAD architecture as described at Figure 3, divided to 4 tiers: (1) presentation and logic tiers, (2) Business tier, (3) Data Access tier and (4) Storage tier.

The storage tier consist of two data structures: (1) metadata and alphanumeric data, and (2) geospatial data. In addition, the storage tier contains two databases: (1) Data database and (2) Management database. The Business tier containing win-services for high resources and heavy GP algorithms, these processes run on a different physical machine. These processes partially described in the following section.

Services for surveyors

Though currently TOPOCAD includes several services that are available for surveyors as tools for their work, such as (1) approximate coordinates convertor (between Israel's national grids, past and current), and (2) a cadastral transformation calculator.

The Approximate Coordinate Convertor applies several computational algorithms for transforming and re-projecting coordinates between Israeli grids (former and current). The Cassini-Soldner grid (established and measured by the British mandate at the 1920s) was not a complete grid for the nation; it spread mainly at civil population concentration. The former Survey regulation let the surveyors build local grids for surveying, thus creating a great variant of accuracies. Thus, the transformation between this grid and any other must rely on parcel-border control-points and not only on base control points.

The irregularity of carrying out a transformation between these grids leveraged SOI to build a process and guidelines for surveyors on how to calculate the transformation parameters properly (mainly translation) between the grids, when the Cassini-Soldner is in use. In-order to contribute to the process of maintaining sufficient accuracy while preforming transformation for cadastral usage and embedded a calculator at TOPOCAD sites for the surveyors.

The cadastral calculator uses two sets of homological points (a set for each grid) and calculates the transformation for two optional types: (1) translation, and (2) conformal (translation, rotation and single-scale). The transformation calculation process uses a LS adjustment for the transformation parameters estimation.

The cadastral calculator takes into account the accuracy ranking index (or level) of the points as internal weights for the LS adjustment. Furthermore, the LS adjustment weighting process based upon hat matrix, which enable quick detection of errors. The weighting matrix is combined from three different weighting technics (1) accuracy based weighting, (2) distance separation from centroid, and (3) hat matrix. Weighting estimates standard deviation between the two homological points [5], thus creating the correlation between the distribution of the points in the sample. The weight functions for each point described at Equation 5and Equation 6, and the weighting matrix built as a block diagonal matrix.

Accuracy weighting matrix for each homological point set is (a value for each position ordinate):

$$\begin{bmatrix} {}^{1}/_{2acc\_rank\_index} & \mathbf{0} \\ \mathbf{0} & {}^{1}/_{2acc\_rank\_index} \end{bmatrix}$$

Equation 5: *Weighting matrix by ranking index (or order)*

$$li = \sqrt{(Ei - E's)^2 + (Ni - N's)^2} \text{ [km]}$$

Weighting component for each homological point set is (a value for each position ordinate):

$$\begin{bmatrix} {}^{1}/_{2\sqrt{li}} & \mathbf{0} \\ \mathbf{0} & {}^{1}/_{2\sqrt{li}} \end{bmatrix}$$

Equation 6 : *Hat matrix weighting*

The complete weighting matrix is a product of all three weighting functions and fulfills the internal ration of a control point (with its homological control point) in the set. Hat matrix as a weighting component for the full weighting matrix is built as described at Equation 7 [6].

Initial weighting matrix P=I

calculating partial differentiate parameter matrix A (via translation and rotation model)

$$N=A^T*P*A$$

$$Hat=A*N^{-1}*A^T*P$$

(A matrix includes points after translation and rotation)

New weight for each control point is set as

$$h = \sqrt{h_{i,i}^2 + h_{(i+1),(i+1)}^2}$$

Equation *7: Hat matrix equations*

Future work

TOPOCAD is an internal product of SOI (R&D division), therefore always under development for more usages. Numerous add-ons for the future versions are: (1) geo-processing engine and services, (2) Big data search engine, (3) cloud server and site infrastructure to match it, and (4) mobile first viewer for maximal screen compatibility.

Services for geodetic measurement solutions will be combined as web-services for the surveyors. These services will validate the measurement minimal requirements addressed by the regulations and guidelines, and will produce a solution for the measurements taken. The services will mainly address measurements taken by TS and leveler (traverse calculations, geometric and trigonometric leveling as well), a site for processing GNSS RINex (Receiver Independent Exchange format) data exists under the main servers of the CORS.

The Big data search engine based on the freeware software and code of ElasticSearch, capable of solving a growing number of use cases. The ElasticSearch engine has numerous advantages, such as, capable of fast working on a big and various data stored in a large storage, updates indexing every morning.

Algorithm improvement for the geo-processing and services are planned for optimal response time, and minimal processing time. Furthermore, information (including calculations results and survey areas) will be shared between the surveyors for maximal coverage and minimal misfit to take place between different surveyors working at same location.

Future version of TOPOCAD will contain a lean management module for detailed geodetic processes, and will have open and free access to all this information, for all surveyors. Furthermore, TOPOCAD will prepare numerous Business Intelligence (BI) reports about the entire working and communication process between surveyors and SOI reviewers.

Conclusions and discussion

Regulations and guidelines set the minimal required field measurement and processing parameters values in order to achieve the needed accuracy-class (or order) for a new control points. Partials of the requirements assist the reviewer to filter and check the measurements taken by the surveyor. Reviewers handle each job in an unbiased fashion and inspect them in a different environment used by the surveyor, hens the random errors of the measurement are being tested and bias-errors and gross-errors are easy to test.

Each project reviewed is solved and cross-checked using a different set of processing programs to keep a maximal level of independency between the surveyors and the reviewer solutions. Afterwards, the solutions are tested by normal-random error distribution shorthand formulas.

In order to accommodate regularized and valid form of communication and accuracy tests, surveyors getting access to online tools and services for testing measurement accuracies and validating their jobs.

TOPOCAD, as a communication platform, will let the surveyor submit the job, only if several properties are marked as passed – such as accuracy ranking, valid check-up control point position etc.

As a future effort, services of field measurement geo-processing, such as TS and leveling, will be accessible to surveyors for processing, or double-checking their results. A web service for post processing GNSS measurements is available via the APN CORS site.

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Applanix announces POSPac Cloud for mobile mapping

Applanix, a Trimble Company, has introduced its POSPac Cloud software for directly georeferencing data collected from cameras, LiDAR, multi-beam sonar and other sensors on mobile platforms. An online version of Applanix' industry leading GNSS-Aided Inertial POSPac MMS™ post-processing desktop software, POSPac Cloud is optimized for air, land and marine environments and platforms and is compatible with a variety of mapping sensors such as LiDAR and cameras. *www.applanix.com*

Phase One Industrial introduces 190MP Aerial System

Phase One Industrial has announced a breakthrough in aerial imaging – the 190MP Aerial System – built on the new, dual CMOS sensor, dual lens iXU-RS1900 camera, which is capable of capturing images at 190 megapixels. This system was designed with input from engineers and leading experts in the photogrammetric field to address a wide variety of challenging aerial applications, such as remote sensing, monitoring, inspection, and disaster management. *http://industrial.phaseone.com*

Airborne mapping system

3D Laser Mapping is helping survey teams to cover more ground in a shorter space of time with a new aerial mapping system. The ROBIN +WINGS Airborne LiDAR system is an extension of the market leading ROBIN mobile mapping unit which allows survey teams to mount the system to a backpack, vehicle or aircraft. The +WINGS system works with both single pole and nose helicopter mounts *www.3dlasermapping.com*

Pix4D Software used to launch Intel Insights Platform

Intel CEO Brian Krzanich has announced the new Intel Insight Platform recently allowing select enterprise customers to accelerate the path from drone flight to business value, transforming drone-data into actionable business insights.

The Intel Insights Platform is a cloud-based data processing, analytics and reporting service which addresses a range of commercial UAV applications and verticals – from inspections and surveying in construction, mining, precision agriculture, oil and gas, and more. Intel is working with Pix4D, among other trusted leaders in the UAV industry, to realise this new product.

LizardTech awarded U.S. patent for LiDAR Point Cloud Compression

LizardTech®, a provider of software solutions for managing and distributing geospatial content, has been awarded a U.S. patent for the compression of LiDAR point clouds (US 9753124). The patented technology provides lossless compression of point clouds captured by airborne LiDAR sensors or terrestrial laser scanners *www.lizardtech.com*.

ISRO working on substitute navigation satellite

A team from an industry consortium is being trained to assemble the IRNSS-1I. Work has begun in Bengaluru to assemble a substitute navigation spacecraft, which became essential after the main backup was lost in a failed launch on August 31, 2017.

IRNSS-1I was earlier approved as a ground spare, to be sent to space in an emergency. The Indian Space Research Organisation has been training a team from an industry consortium to assemble this spacecraft and its lost fellow satellite, IRNSS-1H. Will there be another backup, an IRNSS-1J, and if so, who would assemble it? M. Annadurai, director of ISRO Satellite Centre (ISAC), Bengaluru, said the current approval is for seven navigation spacecraft (all of which are in orbit) and two spares — IRNSS-1H and IRNSS-1I. Should a new backup be sought and approved, it may be part of another model of outsourcing of its satellites to the Indian industry. ISRO has just begun the process of identifying a set of external partners who would assemble its future satellites, he noted. Until now all Indian spacecraft have been assembled at ISAC by its engineers.

Is the Assembly of 1I being advanced? Back in December, the consortium of six industries was given six months to work on each spacecraft. The deadline for IRNSS-1I was around May 2018. Dr. Annadurai said that as of now, the timeline was the same. The launch of 1I, when it was ready, would also have to align with ISRO's other missions, he said. *http://www.thehindu.com*

China to launch four Beidou-3 satellites by the end of 2017

China-based Beidou Navigation Satellite System (BDS) vice chief designer Ran Chengqi said that four Beidou-3 satellites will be launched by late 2017. So far, the network construction of Beidou-1 and Bedou-2 navigation satellite systems has been finished. The system will cover countries and regions along the Belt and Road by next year. *www.ddinews.gov.in*

China's BeiDou-3 satellites get new chips

A new chip for the BeiDou Navigation Satellite System (BDS) was unveiled recently by the GNSS & LBS Association of China (GLAC).

The chip supports the new generation of BeiDou-3 satellites for high-precision navigation and positioning. The positioning accuracy of the chip reaches the sub-meter level without ground-based augmentation. The chip, developed by Shenzhen-based Allystar Technology, also has uses in unmanned driving systems, wearable devices, precision agriculture and smart logistics. The value of the satellite navigation and LBS industry stood at 212 billion yuan (31 billion U.S. dollars) in 2016, up 22.1 percent from 2015, according to the GLAC. Core output totaled 80.8 billion yuan, 70 percent of which came from BDS. *http://news.xinhuanet.com*

DoD, academia test systems for GPS denial

A collection of Department of Defense units and U.S. universities recently found out when they gathered at Edwards Air Force Base to evaluate various aerial platforms in a degraded GPS environment. The week-long test event called DT NAVFEST – short for Developmental Test Navigation Festival – was the first large-scale program of its kind, according to James Cook, KC-46A project manager with the 418th Flight Test Squadron.

"DT NAVFEST was established to provide a locally, more realistic GPS jamming environment in which aircraft platforms and (remotely piloted aircraft) could evaluate their performance under a degraded GPS signal," Cook said. "Other locations around the U.S. provide such environments, but having it locally allowed for direct program input and cost savings to customers by not having to deal with the logistics costs of deploying to those locations."

According to Wei Lee, test safety engineer with the 412th Test Wing, the universities were invited to participate in DT NAVFEST on a trial basis with the hope of expanding to other institutions in the future. *www.af.mil*

Six firm launch contracts booked with Arianespace

Arianespace has received its first two confirmed launch contracts for Europe's new Ariane 6 rocket. Two Ariane 6 rockets will launch pairs of Galileo navigation satellites between the end of 2020 and mid-2021, Arianespace said. The launch contractor signed the Galileo launch deal with the European Space Agency, which serves as a technical agent and developer for Europe's navigation network on behalf of the European Commission. The Galileo launches are the first two confirmed Ariane 6 reservations for Arianespace, which previously signed contract options for potential Ariane 6 flights with satellites for OneWeb's orbiting communications constellation and Eumetsat's meteorological fleet.

The Galileo satellites will ride in pairs on two Ariane 62 rockets, the lighter version of Europe's future launcher. The Ariane 62 will fly with two strap-on solid rocket boosters, while the heavier Ariane 64 will carry four solid-fueled motors. Eighteen Galileo navigation satellites are currently in orbit. Eight more spacecraft will join the fleet over the next year with two Ariane 5 rocket missions scheduled for Dec. 12 and mid-2018.

Like the Ariane 5 rocket, the Ariane 6 will inject the Galileo satellites, built by Germany's OHB with major contributions from Britain's SSTL, directly into a circular orbit more than 14,400 miles (23,200 kilometers) above Earth after liftoff from the Guiana Space Center on the northeast coast of South America. The agreement has an option to launch the Galileo satellites on Soyuz rockets from French Guiana if the Ariane 6 is not ready in time. Ariane Group, a joint venture between Airbus and Safran, is developing the Ariane 6 rocket to replace the Ariane 5 in a public-private partnership with the European Space Agency. *https://spaceflightnow.com*

Airports Authority of India released national register 2017

Airports Authority of India (AAI) which is managing 126 airports (including Civil Enclaves) have taken up the onerous task of preparing a comprehensive National Register containing details of all Civil Airports/ Airstrips in the country and the work carried out is first of its kind. The details of 288 airports/ airstrips could be of use for emergency landing, disaster management/ Defence and security related activities.

GIS lab in Leh, India

A newly established Disease Surveillance Centre (DSC) and GIS laboratory of the Sheep Husbandry Department has been inaugurated in Leh, India. The DSC and GIS have been established under the Pashmina Promotion Programme of Ministry of Textiles, Government of India. The Disease Surveillance Centre is a high-tech laboratory facility currently being operated by trained officers of the department who are supervised by the District Sheep Husbandry Officer, Leh. *www.greaterkashmir.com*

New version of SphereVision 360 Imaging System

Arithmetica has launched a new version of its 360-degree imaging system, SphereVision 1.4. It allows PDF documents to be imported as base maps onto which additional imagery, floor plans and asset information can be added. Users can also place hotspots for referencing additional data onto the base map and into the 360 imagery workflow. *www.arithmetica.com*

OS to support Singapore

Ordnance Survey International (OSI) has been contracted to support project lead the National University of Singapore and the Singapore Government with its continued vision to be a Smart Technology world leader. The two-year project will address the automation challenge of converting IFC-BIM, which is building and construction industry data, into CityGML, an open standardised data model and exchange format that stores digital 3D models of cities and landscapes. *www.os.uk*

Technology to Control Vehicle Emissions in real time

EarthSense Systems is helping develop a system to automatically activate zero-emission running of hybrid vehicles along the most heavily polluted city streets. Using its state-of-the-art Zephyr air quality monitoring sensor, EarthSense will measure local air quality levels, in real time, and upload them to a specially developed hybrid vehicle interface, triggering on-demand zero-emission running instructions in vehicles when pollution levels are high enough.

Known as Project ACCRA and led by Cenex, the UK's first Centre of Excellence for low carbon technology, the project is being undertaken in partnership with Leeds City Council.

Drones enter the sky safely through new technology

Two companies from the Netherlands and Belgium joined forces to show that drones can be managed and controlled using a specially developed small transponder combined with Unmanned Traffic Management software. The new technology was developed by Unifly supplier of transponders that make the drones visible. *www.unifly.aero*

Trimble Expands Portfolio – UAVs

Trimble has introduced that three new GNSS-Inertial Systems for Direct Georeferencing on UAVs: the Trimble® APX-15-EI UAV, Trimble APX-18 UAV, and Trimble APX-20 UAV. Direct Georeferencing with the systems allows the location of image elements collected by Light Detection and Ranging (LiDAR) and hyperspectral sensors to be accurately computed without extensive networks of ground control points, reducing costs while maintaining accuracy to produce maps.

The innovative APX-15-EI UAV features dual inertial measurement units (IMU); one embedded onto the GNSS-Inertial board that is mounted on the UAV airframe with the GNSS antenna, and one that is mounted on an external sensor contained in a gimballed mount. The APX-18 UAV is a single-board GNSS-Inertial solution that supports two antenna heading for the highest accuracy in low-speed multi-rotor survey applications such as building facade scanning. *www.applanix.com/dgforuav*

Powerline construction using drones

Sharper Shape and SkySkopes, in cooperation with an investor owned utility have developed an innovative and unique way to use unmanned aircraft systems (UAS) for powerline construction. The mission uses the Sharper A6 UAS to string sock lines for a 675 kV line construction project. Sock pulling, the act of flying a strong and lightweight rope and attaching it to the towers is typically performed via helicopters or by workers climbing the towers. Both these methods involve risk to both helicopter pilots and ground crews. The use of UAS is eliminating the previously complex process consisting of several steps of reattaching the rope and decreasing the risk of injury for involved people. *www.sharpershape.com*

An integrated drone multi-spectral mapping solution for agriculture

The Fairfax-based company Icaros Inc. based in USA partnered with the supplier of multispectral sensors and analytics software Agrowing to deliver an integrated drone multi spectral mapping solution for agriculture. This new bundled solution integrates Icaros' OneButton Standard Edition with Agrowing's agriculture and multispectral sensor solutions. Icaros has been focused on providing geospatially accurate remote sensing software products and services since 2004. Its OneButton software, initially designed for manned aircraft sensors but now compatible with UASs, allows users to easily and automatically generate geospatially precise, fully orthorectified 2D maps and 3D models from frame-based aerial imaging systems. *www.expouav.com*

SimActive releases Correlator3D Version 7.0

SimActive Inc. has announced the release of Correlator3D™ version 7.0, with complete redesign of its 3D generation engine enabling substantial quality and speed improvements. *www.simactive.com*

Honeywell launches UAV Industrial Inspection Service

Honeywell has launched its first commercial unmanned aerial vehicle (UAV) inspection service, the Honeywell InView inspection service, to help industrial customers improve critical structure inspections while also helping increase employees' safety from many of the risks associated with these often-dangerous working conditions. The new InView inspection service will combine the proven performance of the Intel® Falcon™ 8+ UAV system and Honeywell's expertise in the aerospace and industrial industries with data-driven software customized to the needs of the utility, energy, infrastructure, and oil and gas industries. *www.honeywell.com*

Raytheon Coyote UAVs help NOAA track, model Hurricane Maria

The National Oceanic and Atmospheric Administration used six Raytheon Company Coyote® unmanned aerial vehicles to track and model Hurricane Maria. Launched from a NOAA WP-3D Orion hurricane hunter aircraft, the Coyotes flew directly into the storm, giving researchers an unprecedented view of Maria from a safe distance.

Developed for the military, Coyote is a small, expendable UAV that's air- or ground-launched into environments too dangerous for manned aircraft. The system can fly for more than an hour and up to 50 miles from its host aircraft. *www.raytheon.com*

UN's aviation agency propose to register drones in global database

The United Nations' aviation agency, the International Civil Aviation Organization (ICAO), plans to support a single worldwide drone registry. This singular ledger would be easier for law enforcement to sift through than each country's individual UAV ledger.

That might irk US hobbyists, who fought and defeated the FAA in court when it passed a law to force drone owners to sign up for an American registry. The contentious case ended in a decision that classified non-commercial drones as model aircraft, which don't need to be nationally registered. Whether the US drone community cooperates with ICAO's registry is another question.

Conceivably, the UN agency could run the database itself, though no department has been officially tasked to do it. But the registry is likely a precursor to the global regulations on drone flying and tracking that ICAO has been asked to help create, according to Reuters.

Avast and Aircel partnership

Avast, the global leader in digital security products, recently announced a strategic partnership with Aircel, one of India's leading mobile service providers. Under this partnership, 85 million subscribers of Aircel will have access to Avast Mobile Security and Avast Cleanup (a performance optimization application) as part of the Aircel Protect Suite. *www.avast.com*

Chinese bid for stake in mapping firm denied

Chinese digital map provider NavInfo Co. called off plans to buy a stake in counterpart HERE Technologies after U.S. authorities withheld approval, the latest China-linked deal to run afoul of a secretive American national security panel. The rejection shows the long reach of the U.S. security review process, which effectively scuttled a bid by Asian partners to buy a minority chunk in a European-run company. Beijing-based NavInfo, Chinese Internet provider Tencent Holdings Ltd. and Singapore sovereign wealth fund GIC Pte failed to win clearance from the Committee on Foreign Investment in the U.S. to buy 10 percent of Amsterdam-based HERE, the Chinese mapping company said in a statement. *www.bloomberg.com*

In-car telematics and connectivity platform runs Linux

Linux is finding its way into car systems that move beyond in-vehicle infotainment (IVI) and into telematics and connectivity. Recently Laird showed off a higher-end, OEM-focused "modular and scalable telematics platform" based on an open Linux platform. It also refers to as its Car Connectivity Platform, supports applications including FOTA updates, WiFi hotspots for up to 8x devices, and eCALL emergency calling service, which will be required in Europe starting in April 2018.

This telematics unit connects to a Linux-driven connectivity platform that controls WiFi-ac, Bluetooth 4.x LE, and NFC radios, as well as optional cellular and locational technologies. Connectivity options include various GNSS variants, including GPS/ GLONASS, Galileo, Compass, and dead reckoning using gyro and/or wheel pulse info. *http://linuxgizmos.com*

Baidu announces $1.5B fund to back self-driving car startups

Baidu is putting some serious cash behind its self-driving car push after it announced a $1.5 billion fund that's focused on backing autonomous driving tech companies.

It has prioritized autonomous vehicles in a major way in recent years, so this comes as little surprise. Baidu made its Apollo self-driving car platform freely available to the auto industry earlier this year. That quickly picked up partners and it currently claims around 70, including Hyundai, Bosch, Continental, Nvidia, Microsoft Cloud, Velodyne, TomTom, UCAR and Grab. *https://techcrunch.com*

All-in-one office software for topographical data by GeoMax

GeoMax has announced the X-PAD Office Fusion, the all-in-one office software combining data from multiple sensors into one easy-to-use interface. It manages, combines and processes data from GNSS receivers, total stations, laser scanners and other sensors in one single environment whether from GeoMax or any other provider in the market. There is no need to export the data from one programme to another, and X-PAD also offers all CAD features. The Bundle Adjustment feature performs the final and accurate alignment in order to reduce errors. Personalised reports are then created with little effort. *www.geomax-positioning.com*

New Crescent® Vector™ H220 OEM by Hemisphere GNSS

Hemisphere GNSS, Inc. has announced the Crescent Vector H220, the next offering in a line of new and refreshed, low-power, high-precision, positioning and heading OEM boards. The single-frequency, multi-GNSS H220 provides added benefits over the prior generation H200 with a more robust positioning and heading solution and integrates Atlas® GNSS Global Correction Service. The latest technology platform enables simultaneous tracking of all L1 constellations including GPS, GLONASS, BeiDou, Galileo, and QZSS, making it robust and reliable. *www.HGNSS.com*

Tersus GNSS RTK solutions

Tersus GNSS Inc. has launched its proprietary RTK technology and integrated solutions, the Tersus David RTK box as well as the Precis GNSS Boards & Receivers. Users have the ability to get centimeter-level positioning accuracy and flexible connectivity for applications. Tersus David RTK is the innovative RTK solution for centimeter-level accuracy using smartphone. By plugging into phone with USB cable, The Tersus David turns your phone into RTK rover, GIS collector, RTK base, and so forth. It supports GPS L1/L2, BeiDou B1/B2, GLONASS G1/G2. *www.tersus-gnss.com*

Leica Geosystems, Matterport partner to deliver AEC solution

Leica Geosystemsand Matterport have announced a partnership to deliver a fast, simple solution for creating, modifying, distributing, and navigating immersive 3D and digital images. The effort is aimed at the Architecture, Engineering and Construction (AEC) sector. The partnership is focused on integrating the new Leica BLK360 imaging laser scanner and encompassing Multivista's construction progress documentation services into Matterport's cloud-based platform. *http://leica-geosystems.com*

New high-end GNSS simulator from Rohde & Schwarz

The new R&S SMW200A GNSS simulator offers an innovative test solution for easy generation of complex and highly realistic test scenarios for a wide variety of GNSS applications. Users now have access to 72 GNSS channels that can be assigned to up to four RF outputs. The R&S SMW200A can generate QZSS and SBAS signals as well as GPS, Glonass, Galileo and BeiDou signals. The R&S SMW200A is the first and only high-end GNSS simulator on the market that has an internal noise generator and can generate complex interference scenarios with multiple interferers. All signals (GNSS, noise and interference) are generated directly in the instrument. *www.rohde-schwarz.com*

Dual Frequency GNSS Receiver with cm accuracy by Broadcom

Broadcom Limited has announced the world's first mass-market, dual frequency GNSS receiver device, the BCM47755, designed to enhance LBS applications for mobile phones, tablets and fitness wearables. Equipped with the latest GNSS innovations, the device is capable of centimeter accuracy with minimal power consumption and footprint, enabling an entirely new suite of high-precision LBS applications including lane-level vehicle navigation and mobile augmented reality (AR). *www.broadcom.com*

Hexagon Mining applies HxGN Logic to mine planning workflow

Hexagon Mining has introduced to its MineSight mine planning suite, HxGN Logic, a product designed to help users easily create process workflows for modeling. Logic includes security roles, an audit trail, and flexible data sources, assisting users in managing the process from drillholes to a model. It builds upon the foundation of proven MineSight Basis routines, moving them into an easy-to-follow workflow-building tool. It also integrates with MineSight's other geology solutions, allowing users to launch products such as the Model Calculation Tool, or MineSight Reserve from directly inside the tool. *hexagonmining.com*

Septentrio unveils the new Altus NR3

Septentrio has released Altus NR3: a multi-frequency, quad-constellation (GPS, GLONASS, BeiDou and Galileo) RTK receiver for survey and GIS applications. It features Septentrio's pioneering AIM+ interference mitigation and monitoring system allowing continued operation in the presence of both intentional and non-intentional interference. It combines advanced GNSS features with a robust communications suite together in one compact, low-power and easy-to-use unit. *www.septentrio.com*

SBG Systems launches "SBG +Services"

SBG Systems, leading manufacturer of inertial navigation systems, adds to its catalog a full set of technical services called the "SBG +Services". Dedicated to Surveyors as well as Integrators, these services increase productivity by enhancing utilization efficiency and bringing clever solutions to daily project challenges.

Choosing an inertial sensor is more than matching technical specifications. Professionals face other challenges such as training a new employee, ensure a production with a minimum interruption, or simply secure a budget during several years. To answer all these needs and even more, SBG Systems built a whole range of services: the SBG +Services. *www.sbg-systems.com*

World record set for drones with 4 hour and 34 minute flight

Skyfront, creator of the world's longest endurance multirotor drones for the agriculture, energy and utility industries, has announced that its flagship drone has just set a world record for endurance. The Skyfront Tailwind UAV flew for a total of 4 hours and 34 minutes, 10 times longer than typical battery-powered drones. *www.skyfront.com*

NavHub navigation system launched

The German Ministry of Defense selected Rockwell Collins' NavHub navigation system to provide GNSS availability to a variety of its military vehicles. The NavHub system serves as a next-generation GNSS- and Military-Code (M-Code)-enabled solution for the German Armed Forces. *www.rockwellcollins.com*

Safe City Solution recognition for Hexagon

Hexagon AB has received the "Best Developer Partner Award" and the "Business Win-Win Award" at Huawei Connect 2017 . With most of the world's population living in cities, Hexagon and Huawei have collaborated on the first end-to-end Safe City solution. Hexagon received the awards for its work to develop, market and sell the joint solution with Huawei. The solution has been chosen to solve safe city challenges across multiple projects in 8 countries so far. *hexagon.com*

NPL 322+ New Reflectorless and Prism-only Total Station

Nikon-Trimble Co., Ltd has introduced a new version of the Nikon NPL-322+ Total Station, now available in both reflectorless and prism-only versions. It delivers an economic, versatile, and easy-to-use platform. Nikon's legendary optics effectively allow in more light to give brighter and clearer images. Even in the low-visibility conditions typical in the field.

The NPL 322+ allows you to see more detail and much less distortion, especially over longer distances. Using the same rechargeable long life Li-ion battery as the Nivo series, combined with low power consumption design, the NPL-322+ provides the longest possible time in the field. For convenience, the Nikon NPL-322+ total stations include two batteries and a dual charger, to support even the longest of working days.

GNSS master clock and NTP/PTP time server

VersaSync is a high-performance GPS master clock and network time server that delivers accurate, software configurable time and frequency signals under all circumstances, including GNSS-denied environments. Its compact size and high level of ruggedization make VersaSync suitable for mobile applications in harsh environments. Its small footprint allows for easy integration of the time and frequency functionality into systems architecture.

Unicore launches high-precision GNSS receiver module

Unicore has launched its next-generation quad-system GNSS module, the UM482. The UM482 is a multi-frequency high-precision heading module with a small footprint, supporting the satellite signals BDS B1/B2, GPS L1/L2, GLONASS L1/L2, Galileo E1/ E5b and SBAS. The module is designed for applications such as robotics, drones, intelligent drives and mechanical control.

Skydel Releases SDX 17.8

Montreal, Quebec-based Skydel Solutions has released SDX 17.8 software-defined GNSS simulator. The 17.8 release menu features, among other things: Gaussian noise, spectrum view and GUI improvements, as well as

Trimble News

Expands Field-to-Finish capabilities

New version of Trimble® Business Center and the introduction of Trimble Clarity, a new cloud-based application that enables geospatial professionals to easily visualize and share 3-D point cloud data with clients. The new software versions expand the field-to-finish workflows for survey and mapping professionals, providing a complete solution for the delivery of high-quality geospatial information to clients.

Next-Gen Mechanical Total Stations

Trimble® C5 and C3, the next generation of mechanical total stations to support land survey professionals with their cadastral survey, topographic survey and stakeout needs. Both the TSs come standard with autofocus technology. With premium-quality Nikon optics, the new C-Series reduces time in the field with improved measuring speed and the longest electronic distance measuring (EDM) range of any Trimble conventional instrument. Users can also protect their investment with the optional Trimble L2P (Locate2Protect) for asset security to locate lost, stolen or missing equipment as well as the optional Trimble AllTrak™ location technology for asset management to track and manage jobsite tools.

New Version of eCognition Software Suite

eCognition Suite 9.3 is a software platform for advanced geospatial image analysis for environmental, agriculture, forestry and infrastructure applications. It leverages the latest image feature extraction technology to solve challenging problems faster and more accurately for remote sensing specialists, (GIS) experts, cartographers, photogrammetry and other geospatial professionals.

High-Performance T10 Tablet

Trimble® T10 tablet is a rugged, high-performance data processing platform suitable for a variety of survey and GIS applications. It provides the processing power of a laptop computer in tablet form, enhancing efficiencies for geospatial users in the field. It is an ideal platform for large data sets such as point clouds, images, maps and other complex or processor-intensive data. *www.trimble.com*

Advanced Jamming. Advanced Jamming is an option new to SDX that brings unique interference testing capabilities to SDX users. It leverages the power of the GPU/software-defined radios (SDR) combo to create an unheard-of way to simulate interferences, Skydel states, enabling transmitter trajectories and user-defined waveform creation. It's designed to be very intuitive and powerful. SDX is multi-frequency (upper and lower L-band) and multi-cWonstellation. SDX uses GPU-accelerated computing and SDR, and is available as complete turnkey systems or software only.

Taoglas launches new multiband GNSS antennas

Taoglas has launched a range of high-performance GNSS antennas specifically designed to power the next generation of applications that require highly accurate location capabilities, including navigation, UAVs, surveying, agriculture, and paving the way for the rise of autonomous vehicles. The new antenna range is the most comprehensive series of high-precision GNSS antennas in the market today, and incorporates several new form factors to help drive optimal performance and location capabilities across a wide variety of use cases. *www.taoglas.com*

Advanced Navigation release GNSS Compass product

The GNSS Compass is an all in one dual antenna GNSS/INS that provides accurate heading, position and velocity. All of this is done at a very low price point whilst providing precise figures, making it an accessible choice for many applications.

It is capable of providing accurate heading even during GNSS outages (for up to 20 minutes). This is possible as a result of the INS integration embedded into the product. Additionally, it is not subject to magnetic interference further widening its applications. *www.advancednavigation.com.au*

MARK YOUR CALENDAR

October 2017

Commercial UAV EXPO
24 - 26 October
Las Vegas,USA
www.expouav.com

6th International Colloquium – Scientific and Fundamental Aspects of GNSS/Galileo
25 – 27 October
Valencia, Spain
http://esaconferencebureau.com/2017-events/17a08/introduction

3D Australia Conference 2017
26 - 27 October
Melbourne, Australia
http://3dgeoinfo2017.com

ITS World Congress 2017
29 October – 2 November 2
Palais des congrès de Montréal, Quebec
itsworldcongress2017.org

November 2017

37th INCA INTERNATIONAL CONGRESS
1 – 3 November
Dehradun, India
http://incaindia.org

The 7th China Surveying, Mapping and Geoinformation Technology & Equipment Exhibition
08 - 10 Nov 2017
Nanjing, China
www.tleerw.com/en

PECORA 20- 2017
14 – 16 November
South Dakota, USA
https://www.asprs.org

International Technical Symposium on Navigation and Timing (ITSNT)
14 – 17 November
Toulouse, France
http://www.itsnt.fr

Commercial UAV Show and GeoConnect Show 2017
15 - 16 November
London, UK
http://www.terrapinn.com

INC 2017
27 - 30 November 2017
Brighton, UK
http://www.internationalnavigationconference.org.uk

December 2017

ICG 2017
2 - 7 December
Kyoto, Japan
http://www.unoosa.org

International Symposium on GNSS (ISGNSS 2017)
10-13 December
Hong Kong
www.lsgi.polyu.edu.hk

Esri India User Conference
13-14 December
Delhi, India
www.esriindia.com/events/2017/uc

February 2018

18th Annual International LiDAR Mapping Forum
5 - 7 February
Denver, USA
www.lidarmap.org

GMA: Geodesy, Mine Survey and Aerial Topography
15 – 16 February
Moscow Novotel Center, Russia
http://www.con-fig.com/?lang=eng

March 2018

Munich Satellite Navigation Summit
5 - 7 March
Munich Germany
www.munich-satellite-navigation-summit.org

April 2018

The 7th Digital Earth Summit 2018
17 – 19 April
El Jadida, Morocco
http://www.desummit2018.org/

9th IGRSM International Conference and Exhibition on Geospatial & Remote Sensing (IGRSM 2018
24-25 April 2018
Kuala Lumpur, Malaysia
https://igrsmconf18.wixsite.com/igrsm2018

May 2018

Geoscience-2018
2-4 May
Rome, Italy
http://geoscience.madridge.com/index.php

The European Navigation Conference 2018
14 - 17 May
Gothenburg, Sweden
www.enc2018.eu

GEO Business 2018
22 - 23 May
London, UK
http://geobusinessshow.com

June 2018

7th International Conference on Cartography & GIS and Seminar on Early Warning and Disaster Management
18-23 June
Sozopol, Bulgaria
www.iccgis2018.cartography-gis.com


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our most precise, rugged, and lightweight mechanical total stations yet. Now with Nikon auto-focus and optics, location technology, and full dual-face displays, all backed by the quality and reliabilty that made the Nikon name legendary.
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