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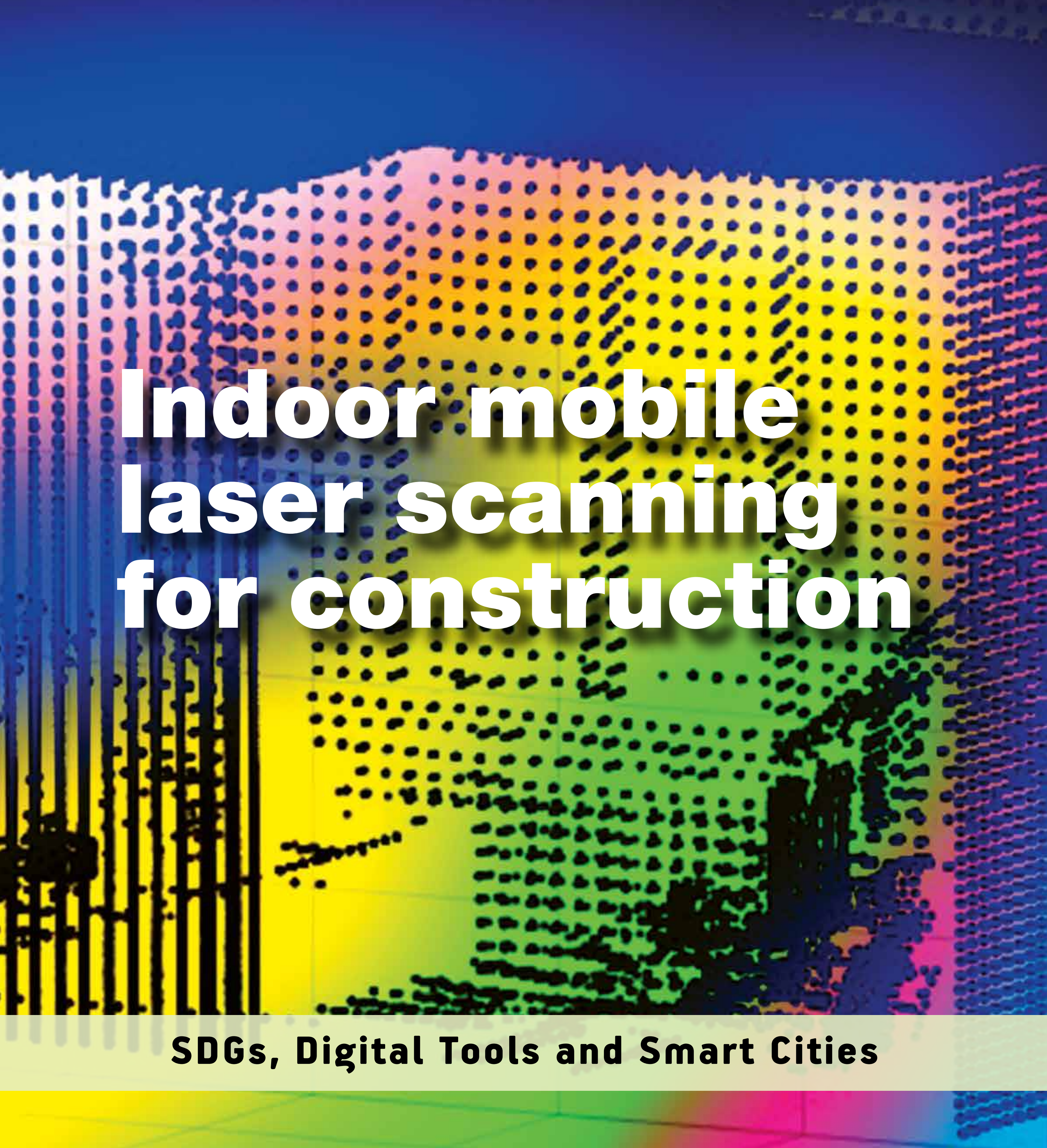
THE MONTHLY MAGAZINE ON POSITIONING, NAVIGATION AND BEYOND



Indoor mobile laser scanning for construction

SDGs, Digital Tools and Smart Cities

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- SBAS: WAAS, EGNOS , GAGAN, MSAS, SDCM
- IRNSS

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MicroSurvey

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Articles

Columns

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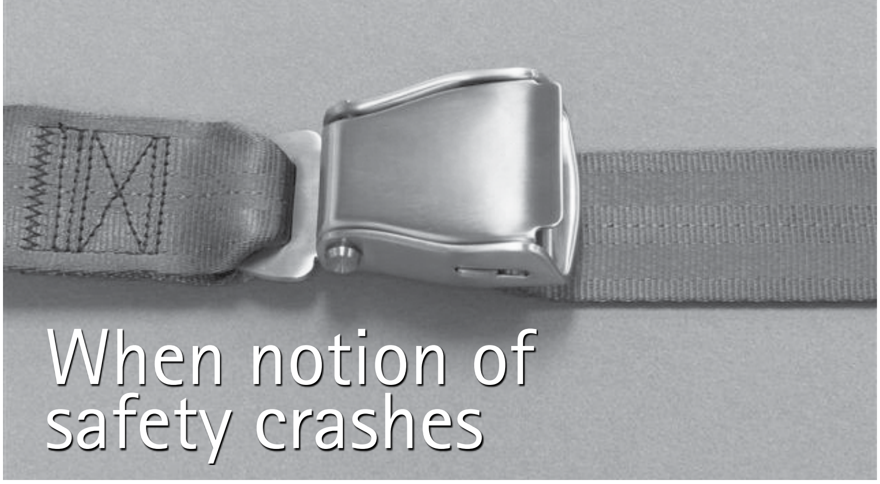


When notion of safety crashes

Two crashes within a short span of 5 months.

In October it was PT Lion Mentari Airlines' Flight 610, Indonesia

And now Ethiopian Airlines Group Flight 302.

Boeing Co.'s 737 Max jet was in service.

Passenger comforts, technologically advanced, cheaper to run,

fuel efficient, …

Wish air safety was a prime sales pitch.

The best-selling plane model in the company's history

354 delivered and another 2,912 as a backlog

Some media reports suggest a similarity in pattern of both the ill-fated planes

Issues regarding new flight-control feature, the Maneuvering Characteristics Augmentation System (MCAS) have also been widely reported.

In a sector, which is highly technical, hugely monopolized and have high commercial stakes, unfortunately the passengers have limited options.

Helpless and hapless!

Bal Krishna, Editor
bal@mycoordinates.org

The GPS Week Number Rollover is coming- 5 things you should know

On 6 April 2019, the Global Positioning System (GPS) comes to the end of its third epoch since it went live in 1980. The transition to the new time period may cause some older GPS receivers to behave strangely, affecting any systems that rely on the time and date information they produce

Guy Buesnel
PNT Security Technologist, Spirent

What is an "epoch" and how does this cause a GPS Week Rollover issue?

The Week Rollover Problem is a known issue caused by the way that GPS used to handle the week element of the data that forms an essential part of the navigation signal.

GPS used a 10-bit field to encode the week number in each GPS time message, which means that a maximum of 1,024 weeks (19.7 years), could be handled. Each of these periods is known in GPS terms as an "epoch".

At the end of each epoch of 1,024 weeks, the receiver resets the week number to zero and starts counting again.

The first GPS satellites went live on 6 January 1980, meaning that the first epoch of GPS time lasted until 21 August 1999. We are now nearing the end of the second epoch, which will fall on the 6 April 2019. That means from that date onwards, we are likely to start seeing rollover problems in GPS receivers that aren't programmed to cope with the week number reset.

The first GPS satellites went live on 6 January 1980, meaning that the first epoch of GPS time lasted until 21 August 1999. We are now nearing the end of the second epoch, which will fall on the 6 April 2019

Is it the "millennium bug" for GPS Receivers?

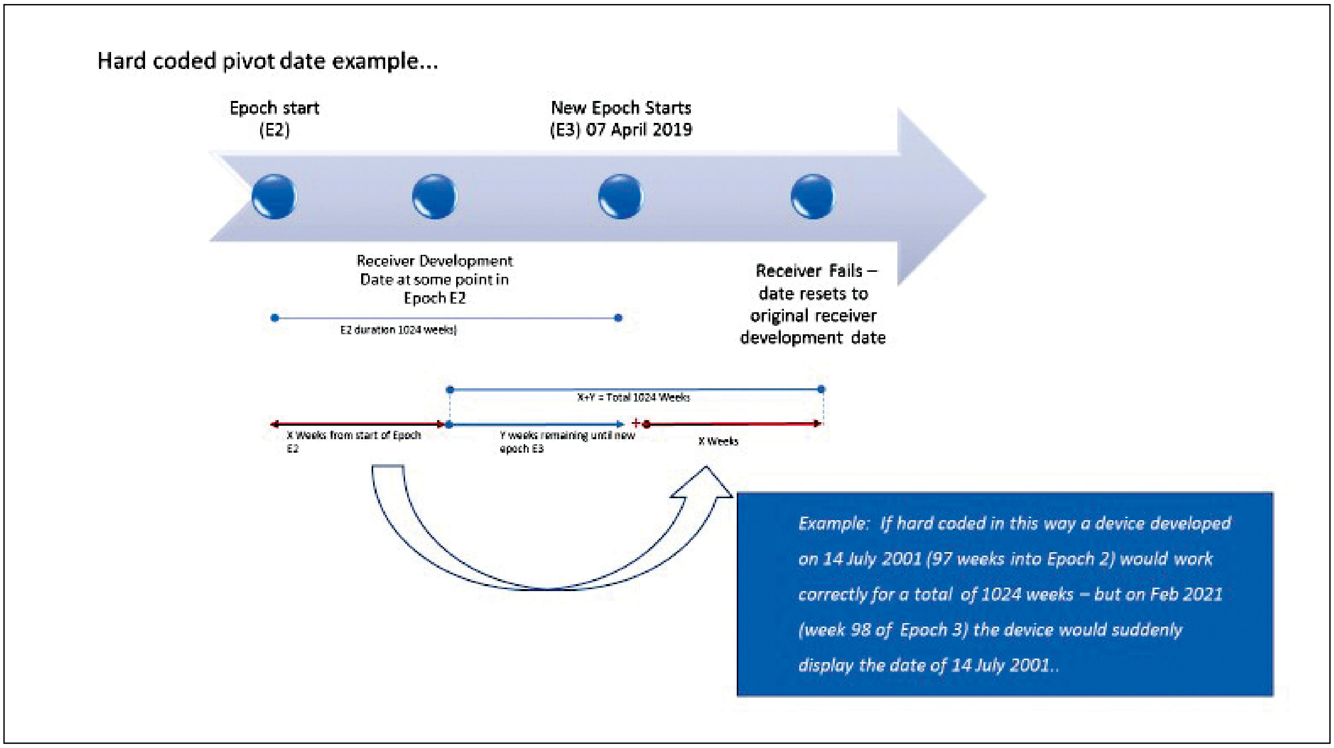
Week Number Rollover issues won't necessarily become apparent on 06/07 April – that's because many device manufacturers realised the limitation of the 10-bit field and worked around it by implementing the 1,024-week limit from the date the firmware was compiled, rather than from the date the current GPS epoch began. This means that older GPS receivers will operate normally for almost 20 years before problems begin to occur.

For example, while the second GPS epoch began on 26 August 1999, a receiver manufactured in January 2005 could have a "pivot date" of January 2005 + 1,024 weeks coded into its firmware – meaning it will function smoothly until August 2025.

Therefore, a week number rollover issue may not manifest on 6/7 April 2019 itself. So, a receiver may continue to work as normal for weeks or months after 6 April but will still reset when its 1,024 weeks are up.

Is this a real problem and what is the likely impact?

Many GPS-dependent systems can be affected by the issue. Several recent reports to the US Coastguard Navigation Center's GPS Problem Reporting database, https://navcen.uscg.gov/?Do=GPSReportStatus show



that the issue is spread across industry sectors, and reveal the kind of behaviour an uncorrected receiver may exhibit. In one of the reports from December 2018, a surveyor in North Carolina reports:

"GPS unit has ceased to display valid date and time information and reverted to the year 1999. I contacted the manufacturer who denied any manufacturing defects and could not offer a solution except to obtain another device at my expense (out of warranty for several years)."

This report is probably related to a receiver developed late in the first GPS epoch, as we shouldn't start to see second-epoch problems until after 6 April 2019. But it also serves to underline the fact that we won't see all issues manifest themselves on 06/07 April but rather over a period of several years due to the implementation of a hard-coded pivot date.

In an affected receiver UTC timing could be displayed and the time tags of receiver data containing PNT information could also jump by 19.7 years Any month/year conversion is also likely to fail. Any external system depending on the GPS receiver to provide it with date/time information is likely to encounter issues with incorrect data.

> It's very quick and easy to test the receiver using a GPS simulator. GPS simulation is a very powerful way of checking for configuration problems such as this and compliance with GNSS ICD parameters

How easy is it to determine whether a receiver is likely to be affected by the Week Number Rollover?

It's very easy to check whether a receiver is vulnerable to the Week Rollover problem: -

1: Identify where older GPS receivers are used in your devices or systems architecture and check the receiver manufacturer.

2: Find out if the manufacturer has issued an advisory and see if you need a firmware update. You may be able to find this on their website, or you can contact them directly.

3: It's very quick and easy to test the receiver using a GPS simulator. GPS simulation is a very powerful way of checking for configuration problems such as this and compliance with GNSS ICD parameters. If you have any doubts about a GPS receiver's ability to cope with the Week Number Rollover, this is the best and most certain way of finding out.

4: If your receiver is affected and there's no firmware update available, you will probably have to replace it.

Won't this just happen again at the end of GPS Epoch 3?

No – GPS now uses a 13-bit field set the week number and most newer GPS receivers make use of this 13-bit field. A GPS epoch in 13-bit data will last for just over 157 years.

SDGs, Digital Tools and Smart Cities

The article addresses the insight of relations of SDGs, digital tools and smart cities, particularly, the imperative instruments of implementing SDGs in smart cities beyond digital tools

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SDGs in data revolution

Sustainable Development Goals (SDGs) are the global strategy with the focuses of 17 global issues, covering the hunger and poverty, life and prosperity, work and living conditions, social justice and partnership, environment and industry in the face of uncertainties regarding economic, social, environmental and political challenges by 2030 [26,27]. Apart from Millennium Development Goals (MDGs), SDGs specially highlight the adoption of data instrument and digital tools in the implementation framework, thus SDGs are as called the global strategy of "data revolution" towards sustainability [12]. In addition, the SDGs point out actions at city levels directly in G8, G9, G11 and G12 and etc., fulfilling the sustainable challenges in cities, which is the other 'revolution' at city levels. Therefore, the two 'revolutions' open the action agenda of smart enablement of cities towards SDGs, particularly, with emphasis of the digital facilitation. In another word, the ICTs as well as the digital tool become the strategic instrumental enablers towards SDGs in smart cities' development.

Among the 17 SDGs, G1-no poverty, G2-zero hunger, G3-good health and well-being, G4-quality education, G5-gender equality, G6-clean water and sanitation, G7-affordable and clean energy, G8-decent work and economic growth, G9-industry, innovation and infrastructure, G10-reduced inequalities, G11-sustainable cities and communities, G12-responsible consumption and production, G13-climate action, G14-life below water, G15-life on land, G16-peace, justice and strong institutions, and G17-partnerships for the goals, G8, G9, G11 and G12 are specifically important in cities, which forms a layer in the middle to support the fundamental layer and higher targets. Therefore, implementing SDGs in cities are crucial regarding the realization of SDGs.

As for the momentum of "data revolution", the overarching SDGs' implementation framework is highlighted in G16 and G17, those are, G16 "Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels" and G17 "Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development" [27]. The ICTs and digital tools are particularly crucial in the terms of SDGs' implementation. As suggested by Risse, "SDGs have a strong focus on the means of implementation, including the targets of finance, capacity building, trade, policy, institutional coherence, multi-stakeholder partnerships, data, monitoring and accountability, as well as public governance and technology" [21].

Digital tools shaping cities

The SDGs emphasize the importance of technological support and digital infrastructure particularly to developing countries. For example, G9 highlights the facilitation of sustainable and resilient infrastructure in the support of domestic technology development to increase the access to information and communication technology by 2020 in the sub-targets 9.a, 9.b and 9.c. Digital tools are regarded as an innovative instrument to boost the knowledge and innovation economy, which is crucial to deliver the smart city discourse [2].

The advancement of technologies has a strong effect on the sustainable development of smart cities. The endowment of big data and digital tools meet with the challenges that smart cities face regarding socio-economic development as well as the quality of life [23]. The common understanding of the use of digital tools is to transmit information among stakeholders to form the core of the public-private-people-partnership ecosystem and agglomerate the advanced competitiveness of citizens and business to create added-value of current circumstances.

In addition, the digital tools provide the opportunities of sharing-economy. On the basis of knowledge of communities, data and tools provide the resources for citizens to 'shape urban change' in smart cities [11, 22]. The communication of information connects the social network, particularly, with the aid of Internet of Things (IoT), the data-based commodity and service in the smart cities provide social mobility, which minimizes the social cost but maximizes the economic benefit.

The concept of digital-driven life is tested in the living labs for the experiment and validation of future smart cities. The living labs assume the labs as digital platforms collaborating the participants and stakeholders who are also regarded as the major bodies involved in the business ecosystem. Normally, the stakeholders include citizens, organizations and local governments in the cities. The benefit of labs is the open access to the public information, data mobility, high-level of interactions, reshaping and operating the innovative social ecosystem [22]. The labs provide the information platform with the facilitation of digital tools, which self-involved and updates by the users. Therefore, the living labs are the user-driven information ecosystem. Users' demand reshapes the cities enabled by digital tools, which is the popular concept in smart cities.

Smart cities, sustainable?

As the discussion of smart cities gets heated, the argument of the difference between smart city and sustainability is raised by practitioners as well as researchers. The common misunderstanding is that smart cities are sustainable. However, the smart cities can only be sustainable on conditions of holistic and integrated framework towards the goals of sustainability.

Currently, the overarching approaches of smart cities are focused on the technology-driven method (TDM) and human-driven method (HDM). The former regards that smart cities are networked places where deploying ICTs into each activity in the city would improve standards of living. It is further emphasized that the use of ICTs by communities will enable them to participate more fully in so-called knowledge societies [6]. However, ICTs alone would not contribute to achieving the desired improvements in living standards, and there exists a need for enhancing human capital and other forms of skill development among the citizenry [20]. The argument is that these dichotomies generate a critical knowledge gap because they suggest divergent hypotheses on what principles need to be considered when implementing strategies for enabling smart city development [19].

Margarita Angelidou also suggests that the smart and sustainable city landscape is extremely fragmented both on the policy and the technical levels. There is a host of unexplored opportunities toward smart sustainable development, many of which are still unknown [3]. Other proponents of smart cities emphasize the potential for promoting economic prosperity, ecological integrity and social equity which would advance the larger goal of urban sustainability [8].

To re-adjust the sustainable path of smart cities, researches during the period of 2017 and 2018 transit from the surface talk of the definition to the deeper insights of the truth of smart cities. For example, the paper was written by Maria Kaika strongly rejected the hypothesis of smart cities being sustainable and resilient [14]. "This relatively simplistic imaginary of the smart city has been roundly critiqued on a number of fronts, especially around the entangling of neoliberal ideologies with technocratic governance and the dystopian potential for mass surveillance" [9,10, 13, 15, 24, 25, 28].

In regard of making smart cities sustainable, the city development strategy should integrate ICTs and data infrastructure with the sustainability goals, generating the economic, social and environmental influences on long-lasting development without the consumption of resources of the next generations. There are several imperative instruments of smart cities beyond digital tools need to be addressed. Because cities are expected being "smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life, with a wise management of natural resources, through participatory governance" [4] .

Imperative instruments of smart cities towards SDGs

The inner goal of smart cities is to improve the living quality of people with the facilitation of digital solutions, such as ICT, big data, Internet of Things (IoT). The initiatives of smart cities are mostly encouraged by local governments in regard to ICT infrastructure development. Under such conditions, the fast effect of enhancement of digital living manners, such as mobile phone communication, broadband construction, online trade and service and etc. is duplicated preliminarily globally. However, the consideration of the accomplishment of smart cities is not directly linked to sustainability. There exists a vast gap in the ideology of both terminologies. Particularly, the experience of the implementation shows the smart city strategy cannot lead to sustainability if the emphasis only based on digital development. Thus, the recent researches show the doubts of simply linking the smart cities with sustainable cities. In the face of such a dilemma, a few types of research start to dig into the institutional instruments of smart cities beyond digital tools. Therefore, the updated understanding is that smart cities can achieve the SDGs on conditions of understanding the imperative instruments of smart cities beyond digital tools towards SDGs, for example, networked infrastructure, knowledgeable community and intelligent governance.

Networked infrastructure

The data infrastructure enabled by digital tools is the foundation of an integrated platform supporting users' communication. The ICTs and IoTs are the special focus regarding the infrastructure. However, the separate data infrastructure is not well established regarding forming effective communications among stakeholders unless the well-connected infrastructure is set up. The networked infrastructure forms the foundation of informative society, which "improves economic and political efficiency and enables socio, cultural and urban development" [13].

The mobility of big data is vital regarding the establishment of networked infrastructure, which is enhanced by ICTs. With the advantage of data mobility, the provision of services and commodities become smart and convenient. Moreover, the interconnected infrastructure provides a sufficient channel to collaborate, stakeholders, particularly, the end users on the smart platform to communicate thoroughly of the needs and requirements.

The feedback can also be timely reflected the counterparts in the communication, so that the prompt response and adjustment are well functioned during the process, which enhances the resilient capacity of the networked group of people. Therefore, the networked infrastructure offers the network instrument, and well-functioning infrastructure to provide the opportunities for reshaping the communication process, enabling the communities' inclusiveness and stimulating the resilience of infrastructure [7].

Knowledgeable community

Improving communities living is the core of making cities smart and sustainable, particularly, in the process of smart city development. As discussed by Hollands, "a smart city is a city that aims at connecting the physical, IT, social and business infrastructures in order to leverage the intelligence of the city's community" [13]. The smart community is the end user and major benefit receiver, who is most likely to take the position of advocating smart cities. Without the support of a knowledgeable community, the smart city is merely a shell of technology and infrastructure. In that sense, the knowledgeable community is crucial in regard to implementing SDGs in smart cities.

However, recent practice in smart cities is not fully understood by local communities. There are several reasons in that regard. First, advanced digital tools are not close to communities' lives excepts for smartphones. The data infrastructure is mostly developed for the working environment of business and government but not close to people's daily lives. Second, the communities are not clear about the benefits that they can get through the tools and infrastructure. Therefore, the training and education processes through various channels are vital regarding delivering the information and technology to communities to make them knowledgeable. On the basis of networked infrastructure, the knowledgeable communities can form the communication capacity at their choices to function the social system towards a more sustainable way.

Intelligent governance

The data-driven revolution transforms the citizens' living style as well as governance structure in a great manner through various aspects. First, the data-driven manner transforms the city growth to knowledge-sharing and sharing-economy, involving communities into the decision process, which drives the decision smarter and closer to the end-needs. Second, the integration of disaggregated data improves the governments' decision-making process [18], which enables governance structure towards a more intelligent gesture. Third, the open data provided by the public sectors creates the transparency of information, and ensure the accountability of counterparts in the connections, monitoring the right role of decision-makers and actors in the well-informed partnership.

[1]The particular emphasis is on the roles of government and community, aiming at the enhancement of transparency, responsiveness and effectiveness and efficiency by the methods of participation, rule of law, consensus, equity and inclusiveness, and accountability.

Governance needs to be intelligent to perceive the right timing for the proper decision, connecting both "top-down" and "bottom-up" communication process and integrating eight factors of good governance with the digital facilitation [30].

The governance structure is more important than ever before regarding shaping the growth path of smart cities. The ICTs change the traditional governmental process to the network governance interconnecting the dependent actors due to social relations on one governance platform [16, 29]. The intelligent governance structure adjusts itself to a flat manner forming the service ecosystem in cities, which is beneficial in regard of fast response and resilient governance [5].

Conclusion

On the discussion of relations of SDGs, digital tools and smart cities, the research sets the backgrounds of SDGs in data revolution and digital tools shaping cities, proposes the question about smart cities' sustainability, and suggests the imperative instruments of smart cities towards SDGs. The general thought is that digital tools are crucial either for SDGs' implementation or for smart cities' development. However, the instruments beyond digital tools, such as, networked infrastructure, knowledgeable community and intelligent governance, are vital for the practical solutions at the smart city level, which is also important for the implementation of SDGs.

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Mine surveying in Finland – Education and professional practices

The standardization of mine surveys, and education related to control surveys, have to be developed in the coming years

Pasi Laurila
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Finland is a European hub for mineral exploration and mine development. Nickel, zinc, copper, chrome and gold form Finland's most significant metal mineral resources. Metal, industrial mineral, and rock mines can be found all over Finland. Especially Lapland, which is located in Northern Finland, and Eastern Finland are important mining areas. Mines in Lapland are the biggest producers of cobalt, platinum, palladium and gold in European Community. Land surveyors are important for mining industry. It is land surveyors' benefit that land surveying is a multidisciplinary science, which has three strong sides, namely measurement science, land management and spatial information management. Mine surveyors are land surveyors who work in demanding working conditions in open-pit and underground mines. They are capable to use highly sophisticated surveying techniques to produce accurately, quickly and efficiently various 2D and 3D representations of the real mining world in purpose to assist various mining operations. In every mine you can find a mine surveyor, or even more. Mine surveyors are especially responsible for maintaining an accurate plan of the mine as a whole. Quite often they are for more than that. Well educated and practiced they can be involved in every aspect of a mining operation. This includes land use planning, legal issues, initial exploration, initial construction of mine operations, ongoing mining works, and rehabilitation of mine site after mining is completed. Mine surveyor can be seen as a kind of manager of the resources of a mine. Accurate surveying starts from control points, which define coordinate and height reference frames. Quite often mine reference frames are local systems. Anyway, coordinate transformations between local and national frames has to be defined, because the national authorities use documents and GIS data sets in the national frame. Control surveys can be seen as a weak point of the present professional practices in Finnish mines. Control surveys, and education related to them, has to be developed in the coming years.

The Finnish minerals sector

Finland is nowadays a European hub for mineral exploration and mine development. With right geology, long mining history and excellent geological data basis, Finland is perfect place to mine and invest in mining. Metal, industrial mineral and rock mines can be found all over Finland, but especially Northern and Eastern Finland are important mining areas. Mines in Lapland, in Northern Finland, are the biggest producers of cobalt, platinum, palladium, and gold in European Community, and the Agnico Eagle Kittilä mine is the largest gold mine in Europe. It extracts annually 1.6 million tons of ore, yielding about 6000 kg of gold (Agnico Eagle 2018a). Also new mines are mostly situated in Lapland and Eastern Finland, supporting the development of these regions. Currently there are three active mines and six mine development projects in Lapland. It is expected that at least five of the development projects will lead to the construction of new mines (Mining Finland 2018).

The minerals sector covers a diverse range of activities, including the mining of metallic ores and industrial minerals, as well as other industries that extract and process aggregates and natural stones. The minerals sector is also considered to include industries that produce and supply machinery, equipment, technology and services for mining operations. In addition the minerals sector is supported by various institutions including research organizations, universities and vocational schools. Mineral resources represent a significant part of the Finnish national wealth. Nickel, zinc, copper, chrome, and gold form Finland's most significant metal mineral resources. The vision for 2050 is that Finland is a global leader in the sustainable utilization of mineral resources and the minerals sector is one of the key foundations of the national economy (The Ministry of Employment and the Economy 2010).

Mining activities fall under the jurisdiction of the Finnish Mining Act, and the Environmental Protection Act, with respect to assessment of environmental impacts. The acts are aimed to promote mining operations and organize the land use, including exploration preceding the mining operations, in a socially, economically and ecologically sustainable manner, with due account for both public and private interests. (Mining Act 621/2011.)

The role of land surveying in the minerals sector

Land surveyor

Ordinary people think quite simply that land surveying is the technique, profession, and science of determining the terrestrial position of points and the distances and angles between them. These position of points and measurements are further understand to be used to establish various maps, property boundaries, and other purposes required by clients and authorities. A more professional approach to land surveying is to see it as a multidisciplinary science, which has three strong sides, namely measurement science, land management, and spatial information management (Enemark 2007). Measurement science refers to surveying and mapping. They are clearly technical disciplines within natural and technical science. Land management refers to cadastral surveying and land use planning, which are judicial and managerial disciplines within social science. Spatial information management refers to GIS, or geographic information system. GIS is a kind of link between measurement science and land management. The strength of land surveying profession lies in this multidisciplinary approach. This is also true with land surveyors who work in the minerals sector.

Land surveyor as mine surveyor

In Finland, land surveyors are involved in many ways in mining operations. These include land use planning, legal issues, initial exploration, initial construction of mine operations, ongoing mining works, and rehabilitation of site after mining is completed. Land surveyors work in public organizations and private companies, which operate in the minerals sector, or which have links to it. Not all of these land surveyors are strictly speaking mine surveyors, but they have certain tasks related to mining.

Mine surveying is a special field of land surveying. Mine surveyors are land surveyors who work in open-pit and underground mines. They are especially responsible for maintaining an accurate plan of the mine as a whole. Quite often they are for more than that. Because land surveying is a multidisciplinary science, educated and practiced mine surveyors are capable to work in many tasks related to mining operations.

Mine surveyor's work starts from the discovery and delineation of mineable ore deposits. After feasibility and economical assessments follows the actual mining activities. They comprise exploration, surveying, construction, drilling, blasting, scaling and reinforcement, dewatering, loading and haulage, and ore enrichment.

Mine surveyors are responsible for maintaining an accurate plan of the mine as a whole. Accurate surveying is based on reliable control points. The maintenance of control network is a very basic task of mine surveyors. Based on the control points, mine surveyors update maps of the surface layout to account for new buildings, other structures, and utilities, as well as they survey the open-pit and underground mine workings in order to keep record of the mining.

Mine surveyors help find precious and non-precious metals and minerals by measuring mines, tunnels and other underground or surface works. Mine surveyors are involved in the measuring process to calculate ore production, in volume or mass units. In addition to this, the volume of the dumps of waste accumulating on the surface of the mining property will also be surveyed. This aspect of the work has turned the mine surveyor into a kind of manager of the resources of the mine (Laurila 2015).

Since valuable minerals occur in a variety of concentrations in the ore, the mine surveyors, in cooperation with the geologists and geophysicists, are responsible for dividing up the ore body into blocks where the average grades of the ore are known. This allows the mine engineers to decide which blocks are economical to extract and which are not. As a result of this information a plan for the extraction of a blended mixture of low and high grade ores can be made. This kind of planning ensures that the mining process is prolonged, the removal of ore is optimized and the metallurgical processing plants, which will not work well if there are large grade variations, are able to operate at consistently high levels of efficiency.

Usually blasting is required prior to excavation. The process involves the use of drilling machines to drill a pattern of bore holes, which are then loaded with explosives and detonated. Mine surveyors are involved in the process by setting out pegs or other marks for an area to be prepared for drilling, marks for drill operators to know where to drill, as well as surveying the material once it has been blasted (figure 1). In open-pit mines, machine guidance systems may be in use. Then drilling machines have GNSS receivers attached and they are able to drill a pattern without the use of pegs. Mine surveyors are responsible operators of these machine guidance systems.

Safety is a big issue in any mine. Surveying and mine mapping has a direct effect on the safety of people working in the mines. Mine surveyors play important role by accurately locating potential hazards, for example flooded tunnels. If an accident occurs, surveying operations must be performed immediately to aid in rescue efforts. Time is important, and confidence in the surveying and mapping system of the mine is essential.

The lifespan of a mine is long, usually decades. After its active time, the mine is closed. Then the plans prepared by mine surveyors become important historical documents. They are possibly used for future mining of the site, if new reasons to open the mine occurs, or rehabilitation and environmental planning of the site, if it is finally closed.

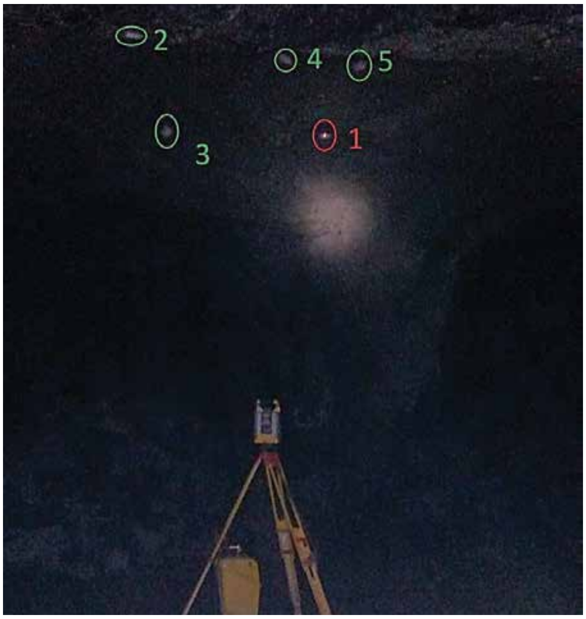

Figure 1. Total station is used to set out drilling pattern in Endomines' Pampalo mine (Ikonen 2014)

Figure 2. Surveying underground in Kittilä mine (Agnico Eagle 2018b)

General competencies for mine surveyors

Mine surveyors use quite conventional surveying practices, but their working environment is very different from other land surveying (figure 2). It is more demanding to work in busy mine than under peaceful open sky. Mine is a constantly changing working environment. A place that was safety previously can be dangerous next time. Air humidity, dust and gases, even dangerous gases like carbon monoxide (CO), create problems for workers, instruments and machines. Traffic is also a major challenge in mines. Mine surveyors have to be creative with traffic related problems when they plan and perform their measurements. (Alatalo 2017.)

In Finland, mine surveyors usually work alone, so they should be self-reliant and their problem-solving skills should be at good level. Mine surveyors should be punctual in terms of working times and surveying tasks. They should be self-critical in order to be able to evaluate their work's meaning for the mining process. The management of the mining process as a whole and the understanding of mining techniques make it much easier to set priorities to their own work and to the use of efficient surveying practices. (Alatalo 2017.)

Mine surveyors requires good knowledge of their measuring instruments and programs. When measuring instruments, computer programs, work instructions or working methods are updated, new properties need to be adopted quickly. Technological development and mining companies' aspiration for higher productivity through automation of operations will change the mine surveying techniques. The technological development enables more detailed information to be available for mining companies (van Wegen 2018). Although technological advances bring new and more efficient measurement methods, many of the conventional ways of doing mine surveys will remain quite the same as today (Alatalo 2017).

Role of research and education

Research has a key role to provide new information and wider knowledge in the mining sector. The challenges, like lower grade ore, demand new expertise in the processes and totally new methods. With ordinary technologies you may have a pile of rocks, but new technologies can change the situation so that you have ore. Education is needed to spread the knowledge and best practices for mining operations. For educational organizations it is essential to provide skilled labor for the mining sector. The mining sector needs vast range of technical and administrative experts. And mines are demanding places to work. That is why we need to teach students to be multidisciplinary, skilled, safety oriented, and responsible employees. (Huhtaniska 2015.)

Mining specific technical studies are available in University of Oulu, Lapland University of Applied Sciences, Kajaani University of Applied Sciences and in three vocational schools, which are all located in Northern Finland. Oulu University offers a degree program in mining and enrichment technology on bachelor and master levels. Lapland and Kajaani universities of applied sciences offer shared studies on bachelor level. The studies have been planned in cooperation with mining companies. The study courses are related to mining technology in general, enrichment technology, maintenance, and mine planning and construction. The vocational schools train miners for drilling, blasting, loading and haulage, and maintenance. All here mentioned degree programs are quite new programs. They have the common problem that the number of applicants for these studies is quite low. Unfortunately this a common problem for all engineering programs in Finland, and worldwide.

In Finland, there are no mining specific studies for land surveyors. Presently most mine surveyors are land surveyors, who have graduated in Lapland University of Applied Sciences. They have reached their specialization trough practical training, and partly through their thesis studies. Generally, mining specific studies are not prerequisite to work in the minerals sector. Most engineers and technical experts for mine companies come from other fields of engineering.

Lapland and Kajaani universities of applied sciences have worked together to develop engineer education in the mining sector for many years. The cooperation has confirmed their role as key providers of engineer education on bachelor level in Eastern and Northern Finland. There have been several development projects. One of the projects has been a virtual learning environment for mining (KaiVi). It is a simulation based, game-like learning environment. It allows for the visualization of the activities and decision-making with cause-effect relationships in mines that are difficult or impossible to do without a virtual environment. The training environment can be utilized in various fields of education, such as infrastructure, maintenance, mechanical engineering, construction engineering, electrical engineering, and automation. The students will learn to work together in a multidisciplinary mining environment. This will improve their readiness to work in mines safely. (Figure 3.)

Professional practices in mine surveying

Control surveys

Accurate surveying depends on reliable control points. They define a coordinate reference frame, or a vertical reference frame, or a combined 3D coordinate reference frame. The coordinates and elevations of the control points are measured with special control survey methods. The purpose of control surveys is to provide a uniform framework of reference for the surveying activities within a given area. Triangulation and traversing are used to define the coordinates of control points. Especially traversing is common method in the narrow underground tunnels. Total stations and GNSS receivers are used to make the necessary measurements for coordinates. For vertical reference system, levelling is still the most accurate method to define elevations of vertical control points.

Baseline is the simplest way to establish the coordinate reference frame. Minimum of two control points define the baseline and the principal reference frame. Mine baseline is usually oriented in the direction of the ore deposit. It is often taken as the X-axis of the local rectangular coordinate system. The reference frame is easily extended from the baseline by traversing or by triangulation with total station.

In general, reference frames can be local, national, continental, or global systems. Quite often mine reference frames are local systems. Anyway, coordinate transformations between local and national system has to be defined, because the national authorities use documents and GIS data sets in the national frames. (Mining Act 621/2011 and Government Decree on Mining Activities 391/2012.)

For example, in Kittilä mine, the control network is extensive. There is a sparse primary control network on the ground, which dates back to 1980's. The primary points defines the reference frame to be the old Finnish national frame, which is not used anymore. The control network continues from the ground through the entrance tunnel and advances along the tunnels to everywhere in then mine, so that there are about 1500 secondary points located on the walls of the tunnels at about 100 m intervals (figure 4). In addition there are approximately the same number of auxiliary points for short term use. Because of the tunnel network expands and mining operations and traffic destroys control points, mine surveyors have to do control surveys continuously. (Alatalo 2017.)

In many Finnish mines, control surveys can be seen as a week point of the present surveying practices. First, problem is that there are no survey standards for control surveys in mines. Second, in many mines the reference frame has been defined long ago without clear documentation. It is possible that the primary points have been destroyed. Third, the mining companies don't necessarily understand the importance of reliable control frame for their operations and safety. Fourth, the mine surveyors are not always familiar with control surveys. It is quite obvious that standardization of mine surveys, and education related to control surveys, have to be developed in the coming years.

Figure 3. Hazard inspection scenario implemented in the virtual model of existing open pit mine in Siilinjärvi. (KaiVi 2016)

Figure 4. Wall control point in Endomines' Pampalo mine (Ikonen 2014)

Total stations

Mine surveyors use various surveying techniques and instruments including total stations, terrestrial laser scanners, satellite positioning, and aerial surveying methods, to make their measurements of surface and underground works. Modern surveying instruments are electro-optical and digital devices, which are controlled by computers and connected to the Internet.

Total stations, or tachymeters, are common surveying instruments used today. In Finland, especially in underground mines total station is the most important surveying instrument. Robotic total stations are available which allow for a single-person operation by controlling the instrument using a remote control. Robotic total stations are also capable to scan the objects, but they are much slower scanners than the special terrestrial laser scanners are. In general, robotics allow for automation of measurements. Robotic total stations make it possible that in Finland mine surveyors usually work alone.

Total stations are used with a prism which reflects light signals back to the measurement device to determine a distance measurement. Most total stations can also be used in reflectorless mode. Then they can obtain a distance measurement to an object without the use of a prism. Reflectorless mode, robotics and automation is important for example in hazardous places where occupational safety is in question.

Total stations are not only used for collecting surveys, but also for setting out designs. Using a total station, surveyor can determine where pegs or other marks need to be placed. Most total stations have setting out features and they can use loaded design information to determine where the marks are located with reference to the control points or the design lines.

Terrestrial laser scanners

A laser scanner combines an electronic distance measuring device and two dimensional orientation measuring device with a scanning mechanism. A terrestrial laser scanner is like a fully automatic total station. The output of laser scanning is often referred to as a point cloud. The term comes from the visualization of the measurements. The points are colored according to the intensity or distance of the return signals and as the result the image appears as a combination of closely spaced dots (figure 5).

The primary capability delivered by laser scanners is to be able to measure very detailed, very accurate 3D-coordinate information across wide areas and to long ranges in relatively short periods of time. It is common for laser scanners to produce hundreds of thousands of measurements in a second. No access to the scene being scanned is required, which is important in inaccessible or hazardous places.

Laser scanners have heavy reliance on software processing to enable the delivery of useful results. The point clouds produced as raw data from laser scanners, while visually impressive, are not immediately applicable as survey deliverables. Generally they require the use of specialized software algorithms and workflows to be fully effective.

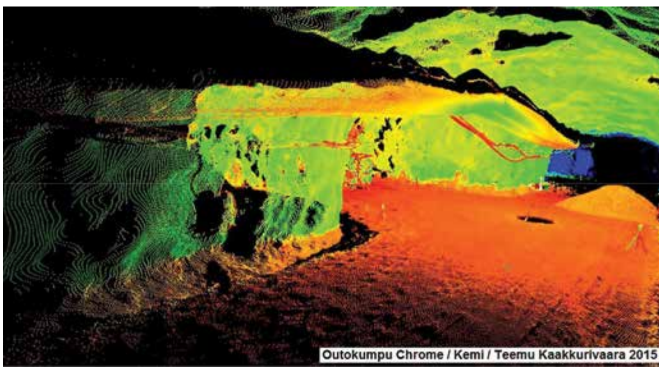

Figure 5. Colored point cloud from Outokumpu Chromes's Kemi mine (Kaakkurivaara 2015)

Satellite positioning

For most of the people satellite positioning means GPS, or Global Positioning System. Professional users of satellite-based positioning are already used to the abbreviation GNSS, or Global Navigation Satellite System. Satellite positioning is based on accurate time determination. The satellite receiver measures the time difference between the transmitted and the received radio signal. The time difference denotes the signal travel time, which reveals the distance between the satellite and the user antenna. Utilizing distance measurements between the user antenna and four different satellites, the receiver can calculate receiver coordinates in a global 3D reference system, which is known as WGS84. Mine surveyors have to work mostly on centimeter accuracy. This is possible with relative positioning techniques, which employ two or more receivers simultaneously tracking the same satellites. Of the two receivers, one is selected as a reference, or base, which remains stationary at a control point. The coordinates of the other receiver, known as the rover, are unknown. The coordinates are determined relative to the base using measurements recorded simultaneously at the two receivers. The rover receiver may or may not be stationary, depending on the type of the survey operation.

Real Time Kinematic (RTK) surveying is a relative satellite positioning technique, which is especially important technique for mapping and setting out surveys. It offers centimeter accuracies in real time. RTK surveying uses measurements of the phase of the signal′s carrier wave, rather than the information content of the signal, and relies on a single reference station or interpolated virtual station to provide real-time corrections. Satellite positioning is possible when there is line of sight form receiver antenna to the satellites. This means that satellite positioning is not possible in underground mines. In Finland, in open-pit mines, satellite positioning is the main measuring technique. In deep open-pit mines it is possible that satellite availability is too low for measurements. Then total stations are used.

Aerial surveying methods

Aerial surveying refers to various methods of collecting imagery by using airplanes, helicopters, or UAVs. Typical types of data are images on various visible and invisible bands of the electromagnetic spectrum, such as visible, infrared, or microwave bands. Also geophysical data, such as aeromagnetic or gravity data, are collected. Aerial survey should be distinguished from satellite imagery technologies because of its better resolution, quality and different atmospheric conditions.

Photogrammetry is a 3D coordinate measuring technique that employs the use of multiple aerial photos which are triangulated. Working in the same fashion as human eyes do to perceive depth, using multiple photos will derive similar information. A mathematical intersection between two photos can be used to determine 3D measurements. In mining, aerial photogrammetry can be used for example to general mapping and environmental monitoring. Aerial photogrammetry also has the possibility to be implemented into GIS systems for visualization, modelling and analysis purposes.

Airborne laser scanner refers to a remote sensing instrument which uses infrared laser to produce point cloud data of a large area while flying over. Laser scanners are often used in mining to assist with engineering and surveying applications.

The most recent development in aerial surveying is the use of unmanned aerial vehicles (UAVs). They are remotely piloted light aircraft that can carry cameras, laser scanners, and other sensors. Advances in miniaturization, communications, strengths of lightweight materials, and power supplies have permitted significant advances in UAV design. Abbreviation UAV refers usually to the aircraft, only. UAS, unmanned aerial system, is a more comprehensive abbreviation. It includes also the ground control system and pre- and post-processing software. The unmanned aerial systems are highly automatic systems, which has made them easy to operate. Because of this aerial surveying methods have come to everyday use also in Finnish mines.

Conclusions

In Finland, many land surveyors work in public organizations and private companies, which operate in the minerals sector, or which have links to it. Not all of these land surveyors are strictly speaking mine surveyors, but they have certain tasks related to mining.

Mine surveyors are land surveyors who work in demanding working conditions in open-pit and underground mines. They are capable to use highly sophisticated surveying techniques to produce accurately, quickly, and efficiently various 2D and 3D representations of the real ming world in purpose to assist various mining operations. In every Finnish mine you can find a mine surveyor, or even two, or more.

Mine surveyors are especially responsible for maintaining an accurate plan of the mine as a whole. Quite often they are for more than that. As land surveying is a multidisciplinary science, educated and practiced mine surveyors are capable to work in every aspect of a mining operation. Mine surveyors could be a kind of managers of the resources of the mine.

Accurate surveying is based on accurate control points. The maintenance of control network is a very basic task of mine surveyors. In many Finnish mines, control surveys can be seen as a weak point of the present surveying practices. It is quite obvious that standardization of mine surveys, and education related to control surveys, have to be developed in the coming years.

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Large scale topographic mapping based on UAV and aerial photogrammetric technique

The paper focuses on the use of UAV and aerial photogrammetric technique to effectively generate large scale topographic map (2D) of Universiti Teknologi Malaysia campus, Johor Bahru, Malaysia

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Photogrammetry techniques become easier, faster and cheaper now due to technological developments for mapping [1], [5]. Development in digital technology has increased the reliability of the data captured by the camera and used to be the actual data. Mapping using non-matrix camera had become renowned due to much cheaper in cost and time efficient. Other study are focusing on low cost mapping system, even though the Unmanned Aerial Vehicle (UAV) was capable in producing digital orthophoto, digital terrain model (DTM) and digital map [2], [3], [7], [10], [14], [15]. The mapping accuracy will be depend on type of lens used in the camera, flight altitude, image resolution, digital camera format, etc.

This study focuses on the accuracy assessment of digital camera of different flying height using unmanned aerial vehicle for production of topographic map. The accuracy is assessed by comparing the UAV images' coordinates with ground control point (GCP) with known values. The ground truth coordinate of GCP were acquired using GPS technique by method real time kinematic (RTK-GPS). Levelling were carried out to transfer height from the existing bench mark (BM). The final product of this study is to produce topographic map and to compare the effectiveness UAV in producing topographic map compared to conventional surveying method. In this study, high resolution digital camera are used in capturing high resolution image using UAV as a platform. The study area is Universiti Teknologi Malaysia (UTM), Johor Bahru, Malaysia.

Study area

The study area is Universiti Teknologi Malaysia (UTM) main campus which is situated at Johor Bahru, Malaysia with an area of 3000 acres. Several ground control point (GCP) and check point (CP) were established around the campus area which comprised of 3D coordinates using GPS observation (RTK-GPS method). The GCP is used in digital image processing such as Agisoft Photoscan to produce photogrammetric output such as orthophoto, digital elevation model, contour line and 3D model. Meanwhile the CP is used for accuracy assessment. UAV is attach together with high resolution digital camera to capture digital images with high resolution to produce digital orthophoto. Figure 1 shows the study area indicated by red polygon that covered whole area of Universiti Teknologi Malaysia (UTM).

Data acquisition

Data acquisition on field is entirely acquired from fixed-wing unmanned aerial vehicle (UAV) with specification of employed autopilot known as the MTD UAV. The UAV is fitted out with the current and advanced technologies such as onboard GPS, fiber optics gyro, autopilot chipset, wireless antenna, electronic speed controller, camera mount, high resolution digital camera, high end transmitter and inertial navigation system.

The endurance of this UAV is approximately 2 hours and weight is 4.5kg. Figure 2 depicts the MTD UAV (fixed wing) used for data acquisition for the study area. Together with its' specification.

Figure 1. The study area of Universiti Teknologi Malaysia

Wingspan: 1800mm
Body length 1220mm
The internal maximum width is more than 13cm
The internal maximum length is 86cm
Empty weight: 1.1kg
Maximum Takeoff Weight: 4.5-5.3kg
Supply voltage: 4-6s

Figure 2. The MTD UAV and its' specification

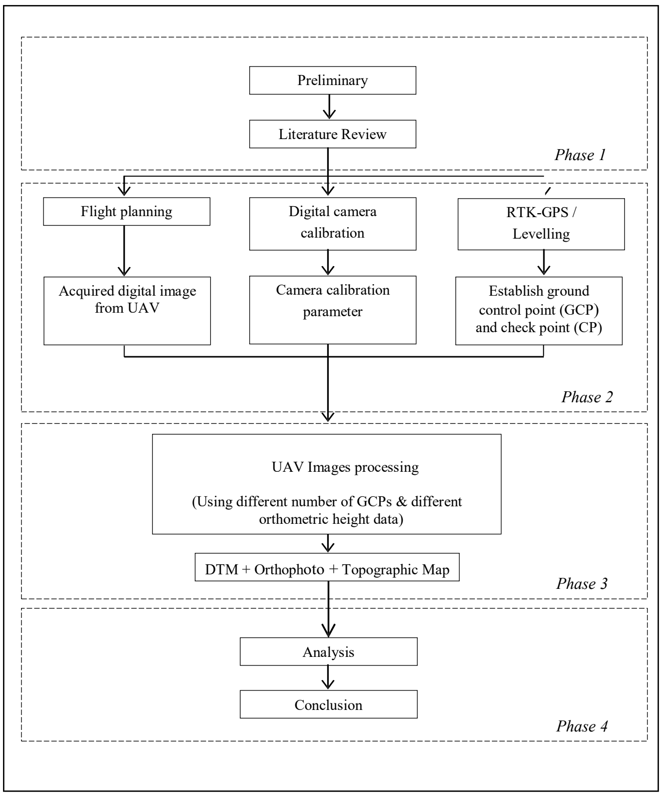

Figure 3. Research Methodology

Methodology

This study consist of four phases which are preparation of study, the literature review, collecting data, data processing, and data analysis which are shown in Figure 3. The literature review briefly explanation of photogrammetry and the UAV development in numerous applications and mapping purposes. The preparation of study elaborate on the instrument used, flight planning and camera calibration as the technical part in execute the fieldwork. The camera calibration is carried out in the laboratory following the standard procedure to recover the camera calibration parameter [16].

In data collection phase, there are two main data to be collected on field which are ground control point (GCP) and check point (CP) that were established using GPS technique RTK-GPS. Another data are camera calibration and digital images captured by UAV at the study area. The determination of GCP and CP location must be well organized and enclosed the study area.

In the processing phase, all the UAV digital images were processed using Agisoft Photoscan software to produce high resolution orthophoto, digital terrain model (DTM), 3D point cloud and texture. The GCP is used in the data processing stage. In this study, the output were successfully produced.

In the analysis phase, the orthophoto is then analyzed by comparing the CP on the image with the actual CP on the ground observed using GPS technique to determine the planimetric accuracy by checking the value of root mean square error (RMSE). For the vertical accuracy, the height coordinates of the CP is compared with the value obtained from the DEM for the corresponding CP. Similarly the RMSE is used to determine the accuracy of vertical coordinate.

Result and analysis

The results obtained from this study include orthophoto of UTM campus, DTM and contour line. The UAV was flown at three altitudes of 250 meters, 300 meters and 350 meters using a digital camera. In this study, the MTD UAV was flown over small area of the study area as shown by the yellow polygon in Figure 1. The rest of the study area will be flown at other time to complete the mission of flying for the whole area which will be divided into several segments. After all the UAV digital images were acquired, it is processed for the three different altitudes using the Agisoft Photoscan software and utilizing the GCP in the study area.

Orthophoto

Figure 4.1 to 4.3 show the orthophoto mosaic for the altitudes of 250 meters, 300 meters and 350 meters respectively. The figures show that as the altitude increases, the coverage also increases and at the same time the number of UAV digital images decreases.

Figure 4.1. Orthophoto Mosaic at an altitude of 250 meters

Figure 4.2. Orthophoto mosaic at an altitude of 300 meters

Figure 4.3. Orthophoto Mosaic at a height of 350 meters

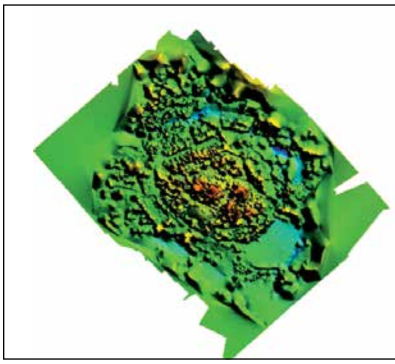

Figure 5.1. DTM at a height of 250 meters

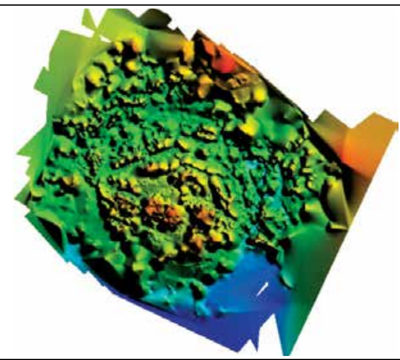

Figure 5.2. DTM at a height of 300 meters

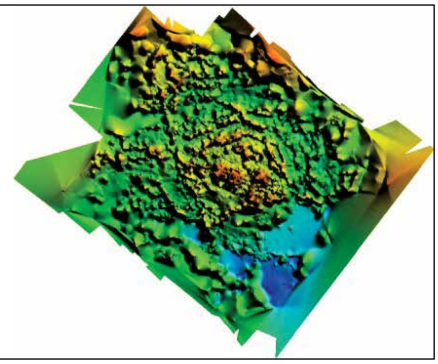

Figure 5.3. DTM at a height of 350 meters

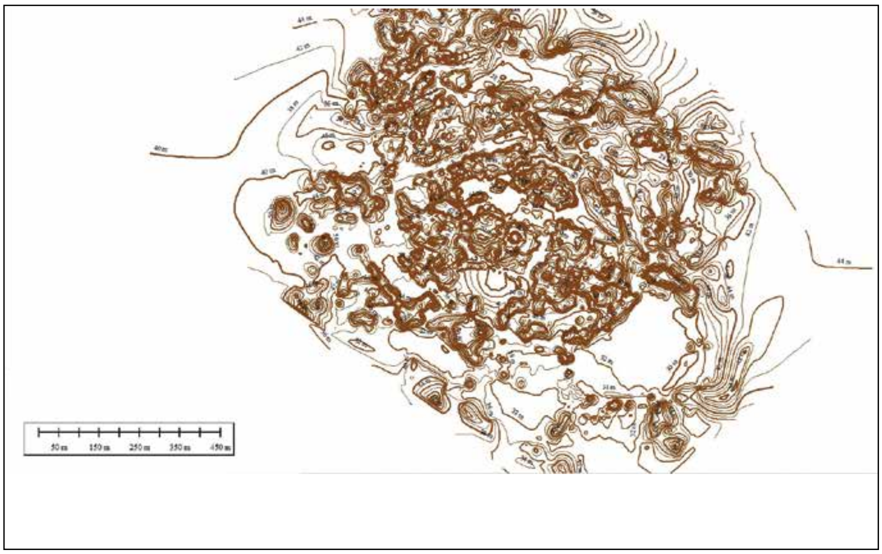

Figure 6. Contour line of the study area for an altitude of 250m

Digital Terrain Model (DTM)

Figures 5. 1 to 5.3 show the Digital Terrain Model (DTM) for the altitudes of 250 meters, 300 meters and 350 meters respectively of the study area. Similar to the orthophoto mosaic, the area of DTM increases as the altitude of UAV increases. In general, the pattern of DTM is the same where the red colour indicates the highest part of the study area while the blue colour indicates low area.

Contour line

Agisoft Photoscan software is capable to produce DTM and 3D point cloud. To generate contour lines, the DTM is exported into Global Mapper 8 software. The contour line is generated for each altitude. Figure 6 depicts an example of contour line at 2meter interval for an altitude of 250m meter.

Topographic map

The digitization process is done on orthophoto mosaics to generate topographic map. The orthophoto is exported to Autocad Map software for the process of digitizing as shown in Figure 7. In this study the orthophoto generated from an altitude of 250m, 300m and 350m was digitized to produce the topographic map.

Conclusion

In this study, the fixed-wing MTD UAV was successfully flown at three altitudes for data acquisition of the study area of the yellow polygon shown in Figure 1. The flight mission does not take long time to complete it. The process of establishing the GCP and CP

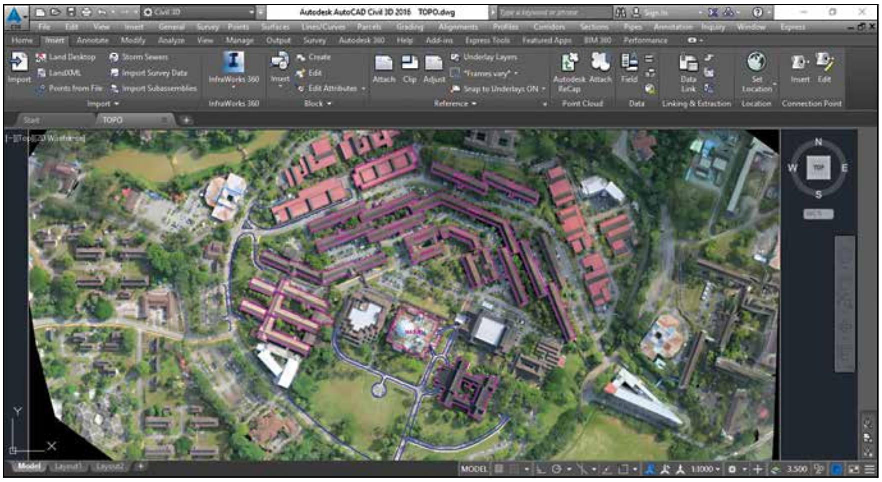

Figure 7. Process of digitizing carried out using Autocad Map software

using the GPS technique take some time. The UAV digital images processing took the longest time compared to other stages. However, all the photogrammetric output such as orthophoto, DTM, 3D model and point cloud were successfully produced. For the accuracy assessment, it was found that accurate results of orthophoto dan DTM were produced at sub-meter level of ± 0.05 meter for planimetry and ± 0.30 for height. The topographic map was also successfully produced based on the UAV digital images. This topographic map can be produced at short time and accurate compare to conventional aerial photogrammetric technique.

In this study, the low cost UAV system was employed and the final output was successfully produced. This system is very applicable for topographic mapping especially for small area compared to conventional aerial photogrammetry in producing topographic map. Also the flight mission can be done at cloud free day, flying under the cloud, save time and economical.

Acknowledgement

We are deeply grateful to Ministry of Higher Education Malaysia (MOHE) for funding this project under Research University Grant Vote No: Q.J130000.2527.16H05. Million thanks also for people who directly or indirectly involved by sharing ideas and provide technical support, throughout this study.

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All GNSS civilian signals

TRIUMPH 3

Based on TRIUMPH chip with 864 channels

- Spread Spectrum • Bluetooth • UHF • 4G/LTE Cellular • Wi-Fi • Integrated GNSS antenna

see back page >

J-Mate Overview

6 pages inside >

J-Mate Test Volunteer

We have delayed the introduction of the new J-Mate to enable us to add new features like replacing liquid vials with a highly accurate internal inclinometer to monitor and continuously compensate for level offsets.

We now are ready to send J-Mates to **20 volunteers in the United States**, who would like test the J-Mate with their TRIUMPH-LS and give us feedback over a period of up to two months.

As a reward for each volunteer's efforts, we will offer a **50% discount on the J-Mate** if they decide to buy it.

Please go to **www.javad.com**, to submit your volunteer application at "J-Mate Test Volunteer".

JAVAD

J-Mate Quick Overview and Update to Videos

First let's set the record straight: J-Mate is not a total-station. J-Mate and TRIUMPH-LS **together** are a **"Total Solution"** which is a combination of GNSS, encoder and laser range measurements that **together** does a lot more than a total station. At long distances you use GNSS and at short distances (maximum of 100 meters) you use the J-Mate along with the TRIUMPH-LS. Together they provide RTK level accuracy (few centimeters) in ranges **from zero to infinity**. Although the sensors are specified to work up to 100 meters, usage is quicker and more convenient for distances of up to 50 meters.

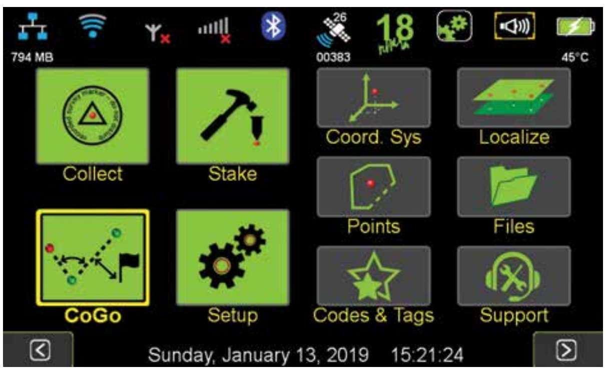
One burden that we leave you with is to focus the camera manually when you need it. If you are always more than 15 meters away from the target, you keep the focus button on maximum and leave it there. We will replace the focus button to make it easier to access if needed.

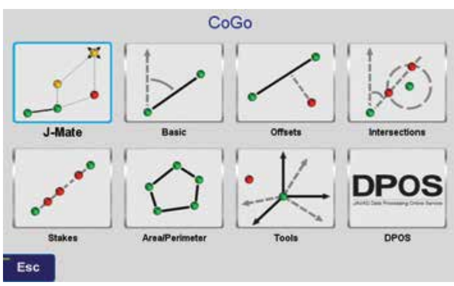
As with the TRIUMPH-LS, with the J-Mate we also provide software improvement updates regularly and free of charge. Download the J-Mate update in your TRIUMPH-LS and then inject it to the J-Mate. When you connect the TRIUMPH-LS to the J-Mate, the injection will be done automatically; but with your consent.

There are many new features in the J-Mate. We try to explain them in a few steps. Please also view the J-Mate videos in our website.

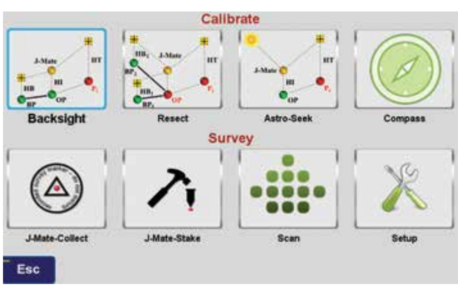
Connecting J-Mate to TRIUMPH-LS:

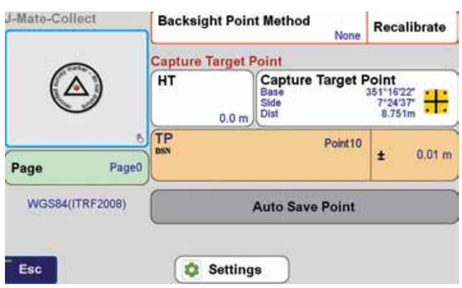
TRIUMPH-LS communicates with the J-Mate through Wi-Fi. Turn on both the TRIUMPH-LS and the J-Mate. Click the Wi-Fi icon of the TRIUMPH-LS Home screen to connect to the J-Mate, much the same way as you connect TRIUMPH-LS to your Wi-Fi access point. J-Mate has ID of the form JMatexxx.





After connection, try to get acquainted with the **Main Navigation Screen**: On the TRIUMPH-LS Home screen, click CoGo/J-Mate/J-Mate Collect/Capture Target points.





Finding the target automatically:

There are three ways to search and find the target automatically:

1) One is by laser to scan and snap to a point when range changes by the specific amount. This is particularly valuable to snap to cables, poles and edges of buildings.

2) Second is search for the object of the specific flat size and focus on its center.

3) Third is with the camera to search for the QR target that we supply. We will discuss these later.

Switching between the two cameras:

You can view the scenes by the wide-angle camera of TRIUMPH-LS, while sitting on top of J-Mate; or by the narrow angle precise camera on the Side of J-Mate. Click Button **“4”** of Figure 1 to switch between the two.

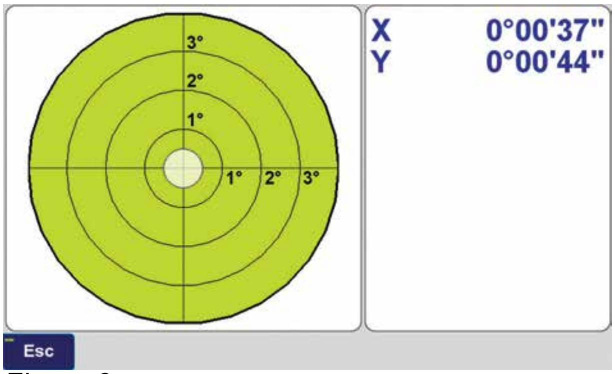


Figure 3

Viewing the embedded Inclinometer:

If you hold button **“4” of Figure 1**, you will see the embedded 0.001-degree electronic inclinometer of the J-Mate as shown in Figure 3. It updates 10 times per second.

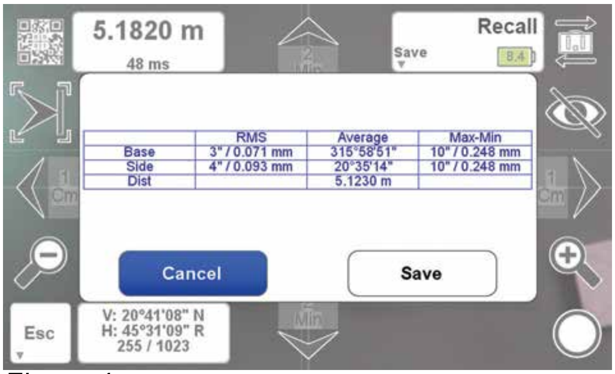


Figure 4

Taking a Point:

When you focus on your target manually or automatically, you can click the “Take” button (**“5”** in the Figure 1). The Encoders will be measured 10 times, the average, RMS and spread will be shown and you can decide to accept or reject (Figure 4). The accepted points will be treated like RTK points but labelled as “JM” points.

You can access and treat them like any other points in the TRIUMPH-LS.

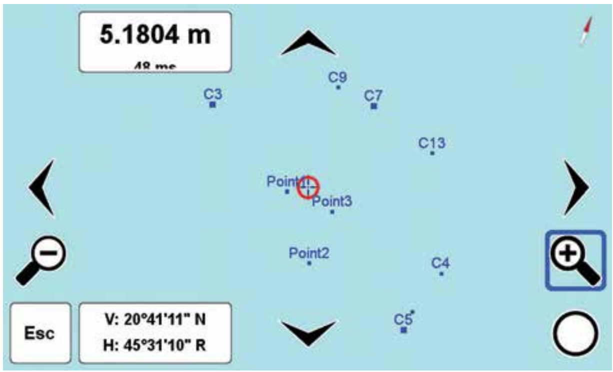


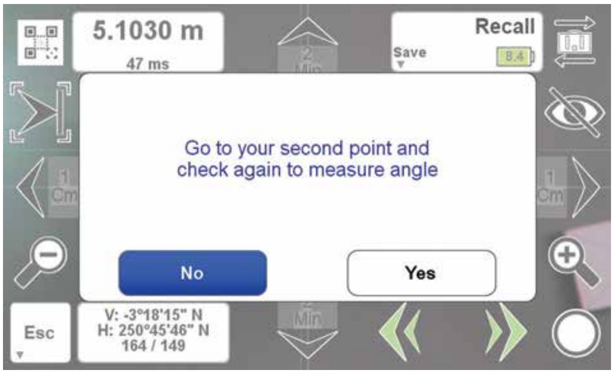
Figure 5

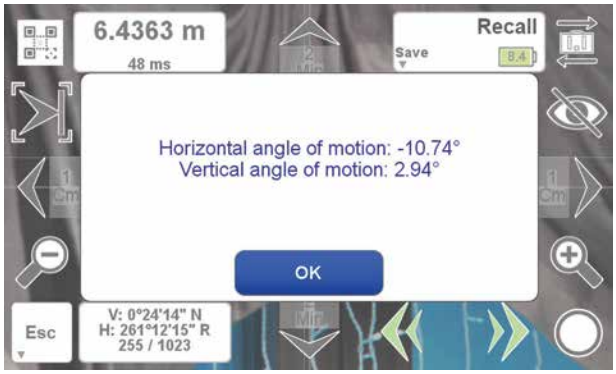
Viewing the Measured Points:

Clicking button **“6”** in Figure 1 will remove some of the items from the screen (Figure 5). Hold it long and you will see live view of the points taken by J-Mate.

Measuring angles quickly:

Aim at the first point and click button **“7”** of Figure 1. Then Aim to the second point and click this button again. You will see the horizontal angles between the two points.





Saving and Recalling Orientations:

Aim at a point and hold long the button **“8”** of the Figure 1 to save the horizontal, vertical, or both of that orientation (Figure 6). Click this button to rotate to that saved orientation.

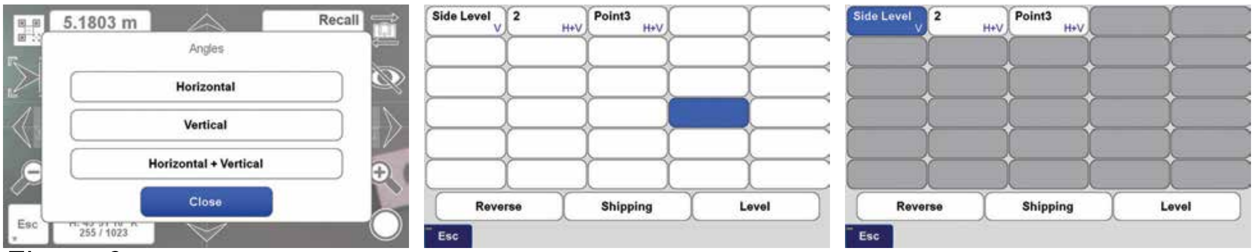
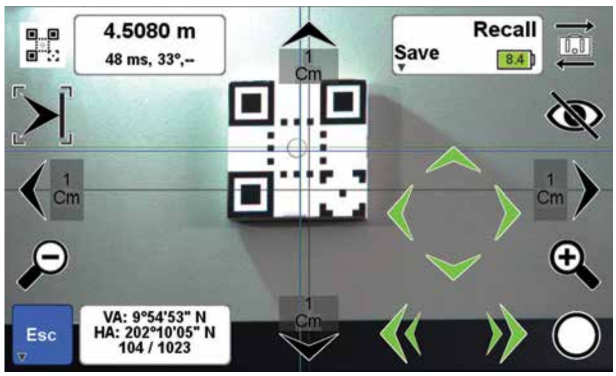


Figure 6

Scanning and Snapping to an object:

Click button **“9”** of Figure 1 and the left and right motion buttons (**“3”** on Figure 1) change to red which means when you click them scanning to snap will start. Hold long button 9 to get to the screen that sets the parameters for the Scan and Snap operation.

In this screen you can define the scan range and ask the scan to stop when range changes by the specified value. Then you can select the point that was measured before the stop or after the stop. By selecting a very large number you can scan the ranges that you have specified and record the 3D image. When you click button 9 to stop change the scanning back to normal motion, you will be asked if you want to save the scanned file. You can view the 3D image of the scanned file in the “File” icon of the Home screen of the TRIUMPH-LS.



Connecting and Re-connecting J-Mate to TRIUMPH-LS

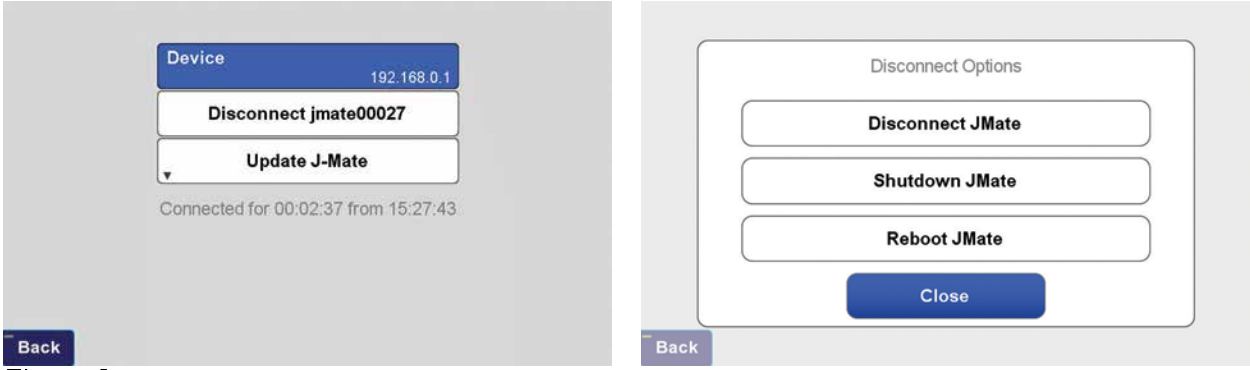


Figure 8

Holding the **“ESC”** button (**“10”** in Figure 1) will take you to Figure 8 which lets you disconnect J-Mate, Reboot, or turn off. Like all Wi-Fi connections, you may lose connection and need to use this screen to disconnect, re-connect, or re-boot J-Mate and in some occasions reboot TRIUMPH-LS too, especially when connection between the camera of the J-Mate and TRIUMPH-LS is lost.

View Range measurements

Box **“12”** of the Figure 1 shows the range measurements. It reads up to 20 times per second.

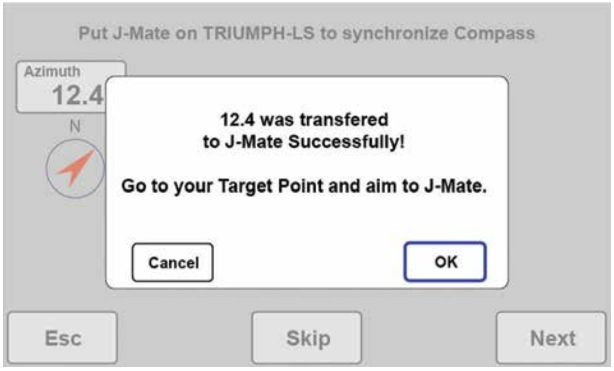
Automatic Finding of the Target:

Click the QR icon (**“11”** of the Figure 1). You will be guided through the following steps to aim at your target point. :

1. Put the TRIUMPH-LS on top of J-Mate (or slightly above it, but at the same orientation as the J-Mate, to be far from the motor magnets of the J-Mate) and click Next.

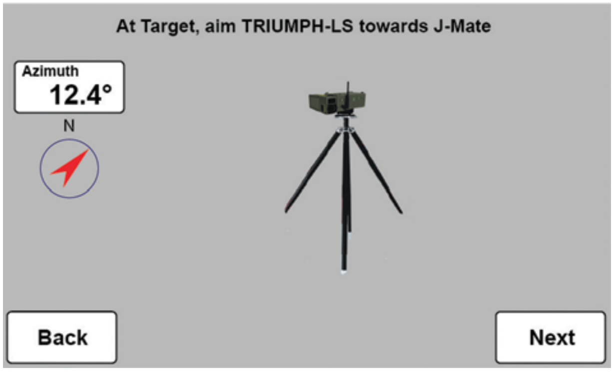
This step will transfer the compass reading of the TRIUMPH-LS to the J-Mate encoders.

You can skip this and the next step if you are in an area that the compass readings are not valid or you can aim manually in the next steps. .



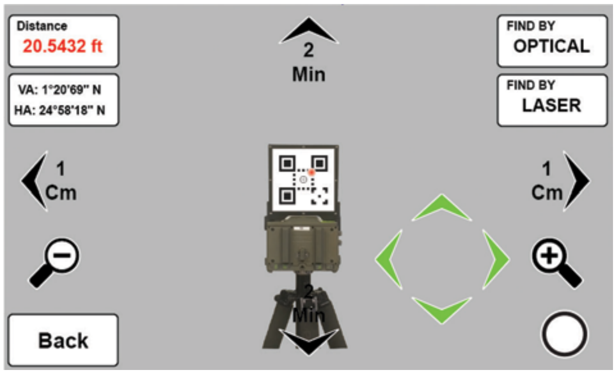
2. Go to your target, Put the QR accessory on top of the TRIUMPH-LS and aim the TRIUMPH-LS towards the J-Mate (with the help of the TRIUMPH-LS camera) and click Next.

This will help the J-Mate to know the general direction to the target and limit its search range. You can go back to previous step to fine tune view of the J-Mate. Or you can skip these two steps.



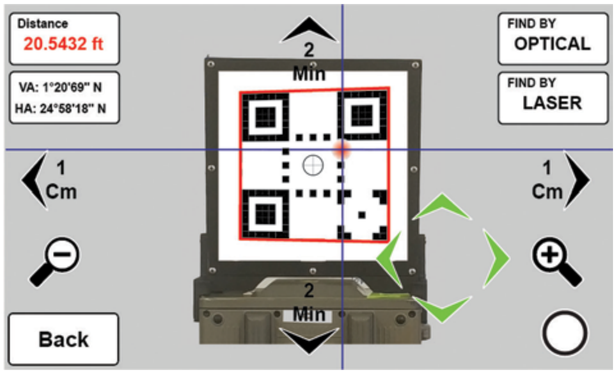
3. You will see the J-Mate camera view on the TRIUMPH-LS screen. You can fine tune the J-Mate view by the navigation buttons to make recognition faster. You can skip these steps if you don't want to make the search faster.

In here you can also manually aim at the center of the QR panel and take your shot.



4. Click "Find by Optical" if you want the QR panel to be scanned and centered automatically.

When J-Mate focuses on the center of the QR, you can click the "Take" button. You will be asked if you want to record the point.



5. If you also want to find the center of the QR by Laser scanning, you can click the "Find by Laser". If Laser scan is successful, you can click the "Take" button to replace the previous measurement with the current measurement done by laser scanning.

The center of the QR is vertically collocated with the GNSS antenna and you don't need to be exactly perpendicular to the J-Mate path. For safeguard, we measure the four sides of the QR and determine the angular offset, if we need it.

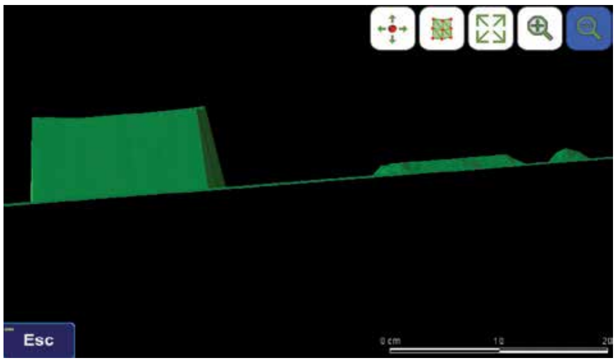
If light condition is such that camera cannot find the QR, chances are better that laser scanner can find it.

Finding the center of QR by laser and by the camera is a tool to calibrate these two sensors together.

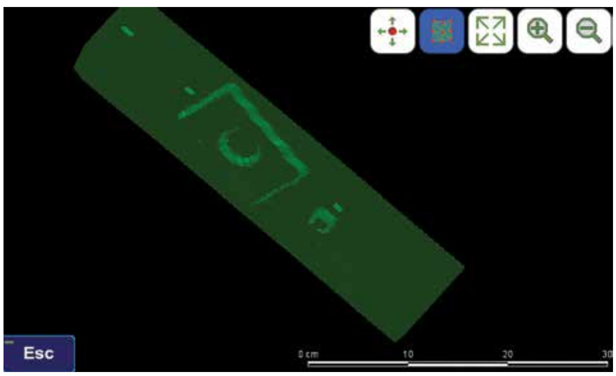
You can run this feature periodically to re-calibrate their axis if you need to. This calibration is small portion of the factory calibration.

You see the 3 views of the 3D scanning

The first scan image is scan of a 1 cm thick and a 6 cm thick objects. 1 cm step resolution.



The last one is scan of a 12.5 x 8 cm object of 1 cm thickness.



This overview as also an update to videos at www.javad.com.

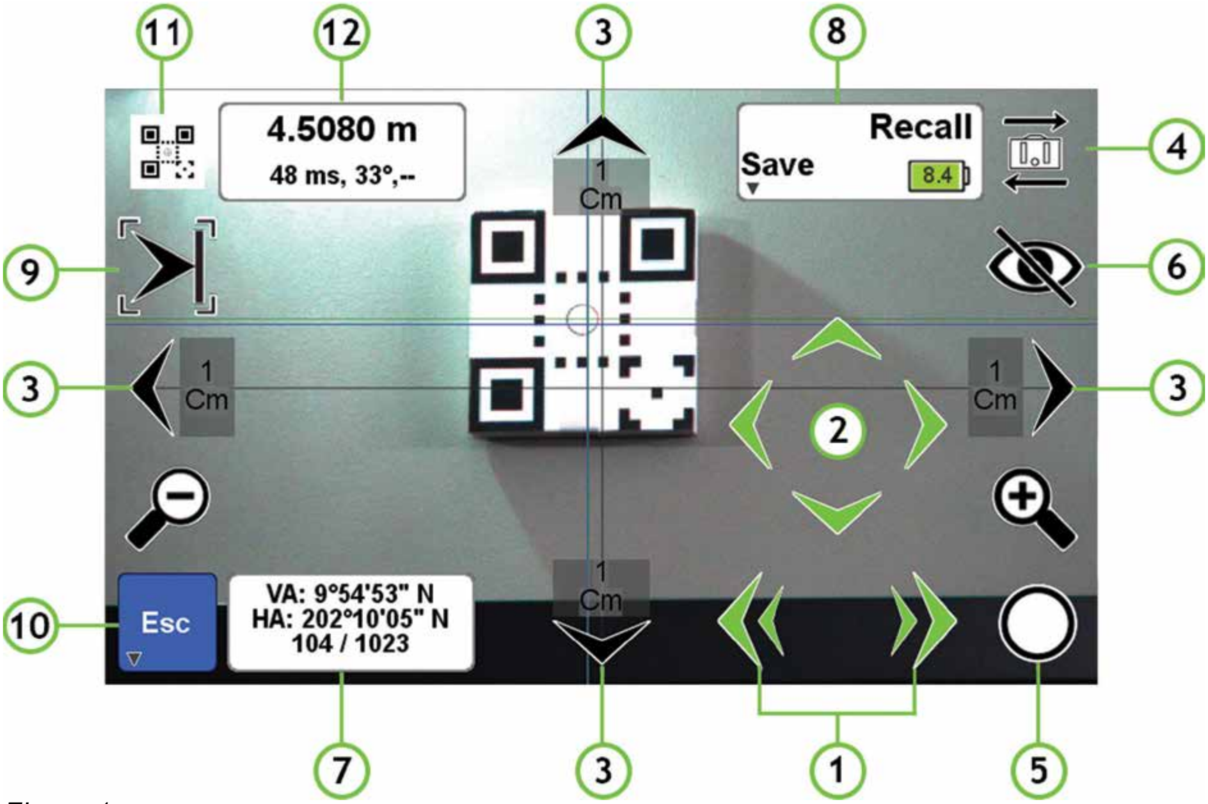


Figure 1

This is the **Main Navigation Screen**

Finding the Target:

You can find targets manually or automatically.

There are five ways that you can manually rotate the J-Mate towards your target:

1. On the bottom right of the Main View screen, there are left and right "Fast Motion" buttons. While you hold them the J-Mate rotates about 30 degrees per second. (**"1"** on the Figure 1)

2. Above them, there are slow Left/Right/UP/Down "Slow Motion" buttons. While you hold them, the J-Mate rotates about 5 degrees per second. (**"2"** on the Figure 1)

3. Then there are Left/Right/Up/Down buttons around the screen. Each click moves the J-Mate according to the value that users assign to them. Hold these buttons to assign angular or linear values to them (**"3"** on the Figure 1). The Value Assignment Screen is shown in Figure 2.

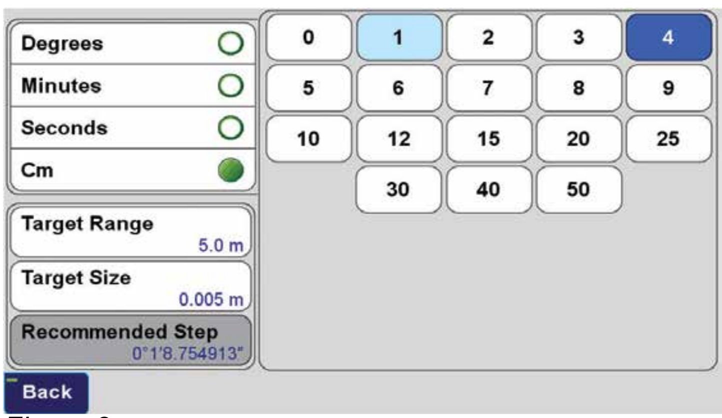


Figure 2

4. Touching points on the cameras and by gestures.

5. You can also rotate the J-Mate manually while it is not moving automatically, but limit that to the small rotations in the area of motor free motion, not to apply backpressure to motor as much as you can. Motor manufacturer does not prohibit manual motion, but we think it is better to avoid that as much as possible.

TRIUMPH-3

The new TRIUMPH-3 receiver inherits the best features of our famous TRIUMPH-1M.

Based on our new third generation a TRIUMPH chip enclosed in a rugged magnesium alloy housing.

The TRIUMPH-3 receiver can operate as a portable base station for Real-time Kinematic (RTK) applications or as a receiver for post-processing, as a Continuously Operating Reference Station (CORS), and as a scientific station collecting information for individual studies, such as ionosphere monitoring and the like.

It includes options for all of the software and hardware features required to perform a wide variety of tasks.

- UHF/Spread Spectrum Radio
- 4G/LTE module
- Wi-Fi 5 GHz and 2.4GHz (802.11 a, b, g, n, d, e, i)
- Dual-mode Bluetooth and Bluetooth LE
- Full-duplex 10BASE-T/100Base-TX Ethernet port
- High Speed USB 2.0 Host (480 Mbps)
- High Speed USB 2.0 Device (480 Mbps)
- High Capacity microSD Card (microSDHC) up to 128GB Class 10;
- “Lift & Tilt”
- J-Mobile interface

Ideal as a base station

2D-based indoor mobile laser scanning for construction digital mapping application

This paper aims to introduce an innovative laser scanning method for indoor construction mapping

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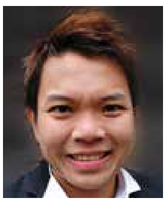

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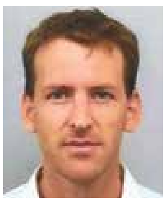

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Various 3D imaging techniques have been developed during the past few decades in order to meet the increasing requirements of industrial and social applications (U.S. General Services Administration, 2009). These techniques are able to measure or capture existing conditions in a natural or built environment, and then present them in 3D images for modelling aims. The generated 3D models are widely used for urban planning, landscape design, topographic analysis, environmental management, simulation of construction, disaster forecast, etc (Bosché, 2010). A valuable application of 3D imaging for architectural, engineering and construction (AEC) industry is the as-built quality control from construction mapping (Akinci, et al., 2006). As a well-known modern imaging technique, laser scanning (also known as light detection and ranging (LiDAR)) is developed for geospatial mapping and surveying (Klein, et al., 2011). The benefits it brings such as increased accuracy, reduced errors and rework, shortened schedule, improved quality control, 3D visualization and spatial analysis, make it appropriate for the civil and built environmental applications, particularly for indoor mapping and construction quality control.

However, conventional laser scanning technologies such as terrestrial laser scanning (TLS) and aerial laser scanning (ALS) although can provide very high measurement accuracy and large measurement ranges, their applications are constrained by high capital costs, site scale limitations, complex preparations and long duration (Fryskowska, et al., 2015; Kedzierski, et al., 2014). Therefore, this paper will propose a novel 2D-based indoor mobile laser scanning method for construction digital mapping.

This method integrates an IMU-GPS (Inertial Measurement Unit – Global Positioning System) positioning system with a portable and low-cost 2D laser scanner to realize 3D indoor mapping for an existing building room (Lee, et al., 2016). Then the mapping results are compared with the 3D design model of the building room, which is created by using Building Information Modelling (BIM). This comparison can help stakeholders to find out the discrepancies between existing construction and design model. Furthermore, it also gives a fast 3D mapping for real-time building indoor conditions to realize time-saving and cost-saving applications.

Literature review

Mobile laser scanning (MLS) is attracting more and more concerns due to its flexibility and mobility compared with TLS (Thomson, et al., 2013). Relevant concepts about mobile mapping systems were announced in the late 1980s and early 1990s (Barber, et al., 2008). Initially a 3D laser scanner was mounted on vehicles to rapidly capture information from existing natural or built environment. Nowadays portable and small-sized laser scanners are developed in order to bring users more convenience and make access into narrow and limited sites, such as corridors and roofs (Fryskowska, et al., 2015). Although the accuracy of MLS is lower than that of TLS, the benefits of cost and time saving brought by MLS still make it competitive. Currently, laser scanning is not only used for exterior mapping and surveying, but also considered for indoor application (Thomson, et al., 2013). TLS can be used for indoor quality control of as-built constructions. Combined with the technical assistance from ALS, the 3D presentations of building interior and exterior scenes can be implemented through the data integration of both laser scanning technologies (Kedzierski, et al., 2014).

Currently, for the AEC industry, 3D point clouds obtained from laser scanning usually are used for two main applications: quality control of as-built constructions and restoration of existing buildings (Alomari, et al., 2016). The point clouds which capture the real conditions of as-built or existing buildings and built environments are compared with their 3D design models through intermediary tools. The building design models are created and exported from BIM software, such as Autodesk Revit. BIM is an emerging technology for AEC industry in recent years. It is not only a 3D modelling tool, but also an innovative way to realize 3D visualization and multi-dimensional simulation for building project lifecycle from planning stage to operation and maintenance phase (Eastman, et al., 2011). Compared with traditional CAD (Computer Aided Design), BIM brings lots of benefits for construction projects, such as design optimization, clash detection, multi-disciplinary collaboration, time and cost savings (Eastman, et al., 2011). Its integration with laser scanning can help find out discrepancies between as-built constructions and corresponding design models (Alomari, et al., 2016). Furthermore, the 3D information captured from laser scanning is able to help implement the indoor mapping and scene restoration of existing buildings and built environments (Bassier, et al., 2016). Based on the real captured data and BIM 3D modelling, stakeholders can make a repair or retrofit plan for existing buildings, particularly for those historical constructions.

However, there are still some challenges which constrain the applications of conventional 3D laser scanning. From the technical aspect, the pre-work for 3D terrestrial laser scanning such as target assignment is tedious and its quality can influence the scanning results. In addition, users need to register and process the collected 3D datasets into point clouds by using bundled software after scanning. This step is time-consuming and the quality of 3D point clouds can be impacted by manual operation errors if users are not trained to a certain level (Hong, et al., 2015). Although Simultaneous Location and Mapping (SLAM) has been proposed in recent years to overcome the defects mentioned above, but due to the technical problems such as nonlinearity and incorrect association between observation and landmark (Thomson et al., 2013). From the economic aspect, the capital expense of a high-performance 3D laser scanner and bundled software is costly, people who intend to use this technique and meanwhile have budget control will consider this inevitably.

Methodology

To maintain the advantages of MLS and eliminate the barriers of conventional 3D laser scanning mentioned above, a novel indoor mobile laser scanning method is proposed. This method combines a 2D laser scanner with an IMU-GPS positioning approach to realize 3D indoor mapping. Different from the point clouds which are registered and generated from captured 3D raw datasets, this method integrates 2D scan images with the motion trajectory of the laser scanner in order to create 3D imaging for existing environments.

Figure 1. SICK 2D laser scanner

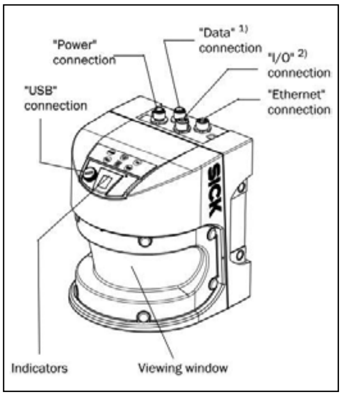

Figure 2. Instruction of laser scanner (from SICK AG)

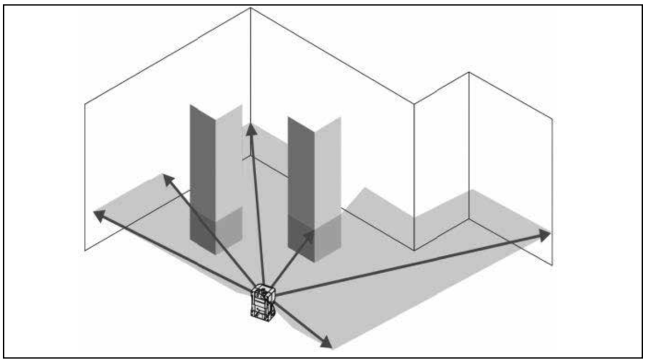

Figure 3. Scanning field in horizontal view (from SICK AG)

In this research, a SICK 2D laser scanner is used and the type is an LMS5xx LiDAR sensor that uses 905nm infrared as the light source (shown in Figure 1) (SICK AG., 2017). Compared with 3D laser scanners, it has much lighter weight and smaller size. Of course, the expense of this 2D laser scanner is also much cheaper. In addition, it has an operating range from 0-80m with high resolution and an aperture angle of 190o (view setting from -5o to 185o) (SICK AG., 2017). If the viewing window of the 2D laser scanner is kept horizontally as shown in Figure 2, the scanning field will display as Figure 3 shows.

As our research aim is to integrate 2D scan images with a trajectory acquired from IMU-GPS positioning system for 3D mapping, the viewing window of the laser scanner should be kept vertically as shown in Figure 4. Therefore, 2D scan images are presented in X and Z (or Y and Z) axes and the motion trajectory of the laser scanner is shown in Y (or X) axis.

To determine the motion trajectory of the laser scanner, an IMU-GPS positioning system was proposed for this research (Stephen, et al., 2006). This positioning system consists of a strap-down IMU and a GPS module. However, GPS is not available for indoor positioning due to the signals will be obstructed by building fabrics such as walls and ceilings. Therefore, IMU was adopted in this research to predict reliable motion trajectory information and fill the vacancy of GPS signal outages (Klein, et al., 2011). Typical IMUs consist of three-axial accelerometers, three-axial gyroscopes and magnetometers. The accelerometers is used to measure the accelerations of the object in x, y and z axes and the gyroscopes are used to measure the angular rate (the rate of turn) of the object in roll, pitch and yaw axes (Stephen, et al., 2006). By integrating the acquired three-axial accelerations, it is able to obtain the velocity of the object which the IMU is mounted on and integrating the velocity again, the displacement of the object is calculated. Magnetometers are used to prevent the orientation errors by utilizing the magnetic north as a reference (Hellmers, et al., 2014).

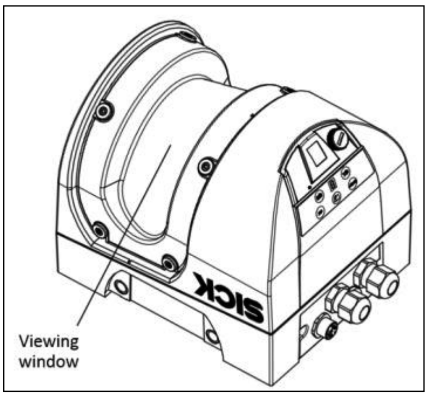

Figure 4. Scan setting in vertical orientation

Figure 5. Experimental site room

For this research, IMU is an appropriate option due to its low-cost, small sized and low energy consuming characteristics (Klein, et al., 2011). However, it can only give accurate predictions in a short term and the errors will accumulate over time. That means the measurement accuracy cannot be guaranteed in a long-term application. Therefore, the positioning results were calibrated by using filters during the data processing.

In addition, it is also crucial to realize time synchronization between the IMU-GPS system and the laser scanner. Because each position of the motion trajectory should be mapped to the corresponding 2D scan image which is generated by laser scanner at the same time. After the synchronized scan and positioning experiment, all the collected raw data will be processed through a MATLAB-based algorithm.

Experiment

During the experiment, a computer room was used as the site (shown in Figure 5). The laser scanner and IMU were mounted on a trolley (shown in Figure 6), which was driven in an approximate linear motion from north to south and east to west. Then both laser scanner and a strap-down IMU (shown in Figure 7) were connected with a laptop by wires. The laptop was used to observe the scan profile and the IMU measurements. In

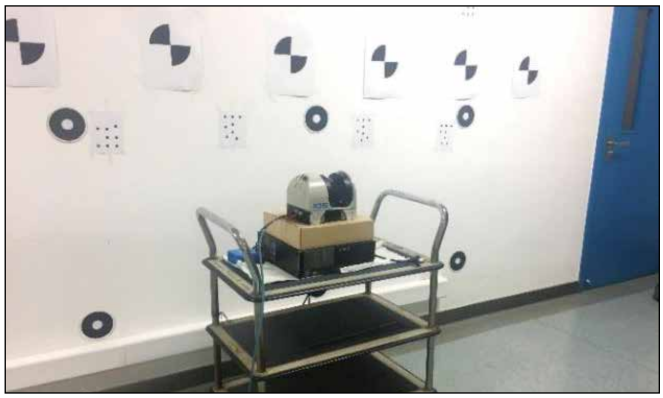

Figure 6. Laser scanner and IMU on a trolley

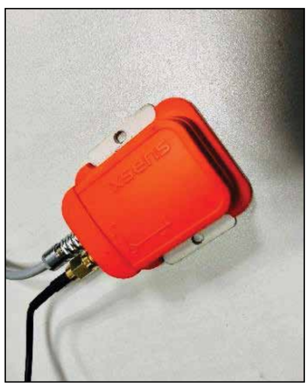

Figure 7. Strap-down IMU

Figure 8. GPS module

addition, a GPS module was also connected with the laptop in order to synchronize the setting time of laptop with GPS time (shown in Figure 8). As IMU has its own measurement time record and the laser scanner uses laptop time, it is necessary to synchronize the IMU measurement time with laser scanning time by using the common GPS time. Although the experimental site was indoor, the GPS time was maintained continuously when we moved the module and laptop from outdoors into the room.

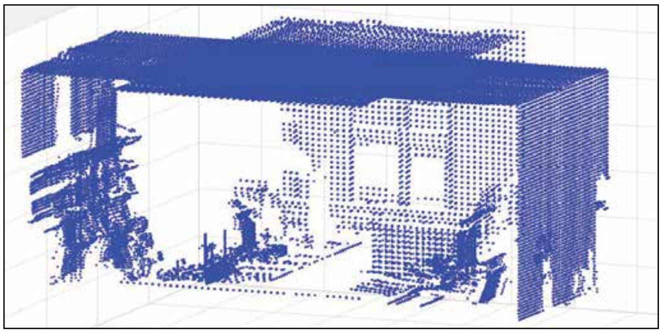

Figure 9. Integrated 3D point clouds (without northern walls)

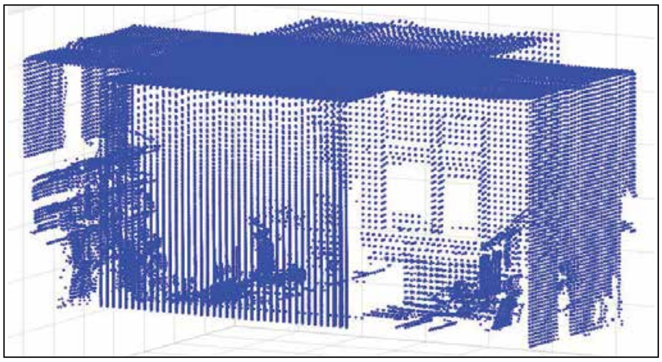

Figure 10. Integrated 3D point clouds (with northern walls)

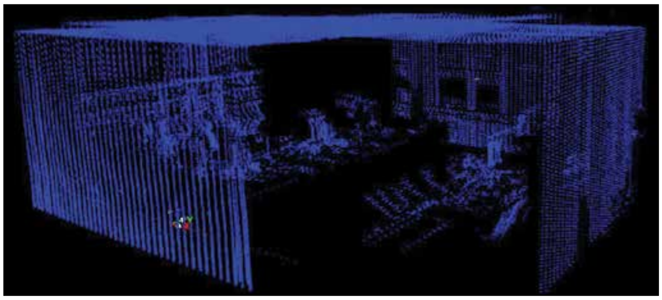

Figure 11. Created point clouds in Cyclone

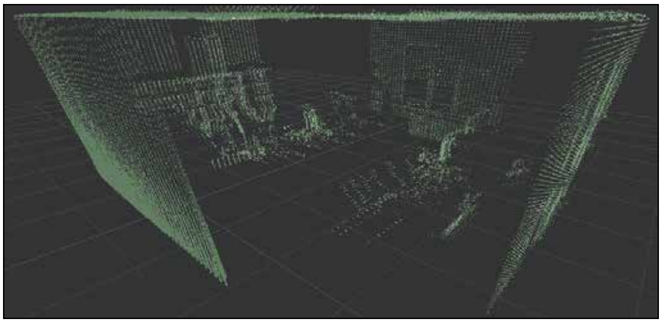

Figure 12. Created Point clouds in Autodesk Recap

First the scan was implemented from the northern side of the room to the southern side by trying to keep the trolley in an approximate linear motion, then this was again from the eastern side to the western side. Meanwhile, the relative positions of the 2D laser scanner and the IMU were maintained in order to eliminate the errors caused by relative displacement. This can be realized by fixing the centers of both devices on a vertical shaft. As the vertical elevation difference between the viewing window and the ground was 0.7m, the scan results would only show the profile images above this elevation.

Result analysis

The 2D scan results were displayed and saved by using the SOPAS Engineering Tool, which is a bundled support software

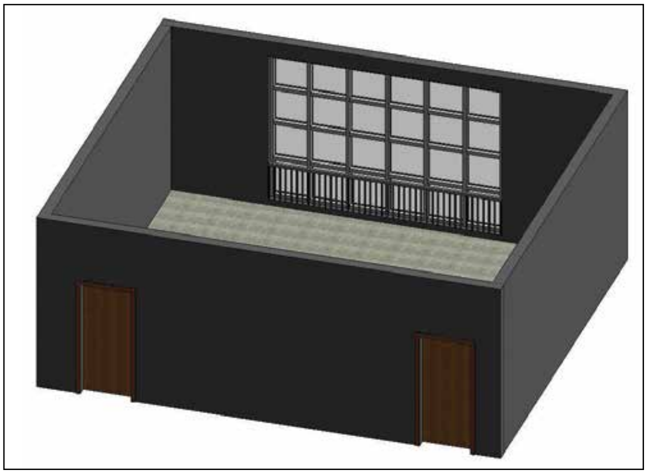

Figure 13. BIM design model of the room

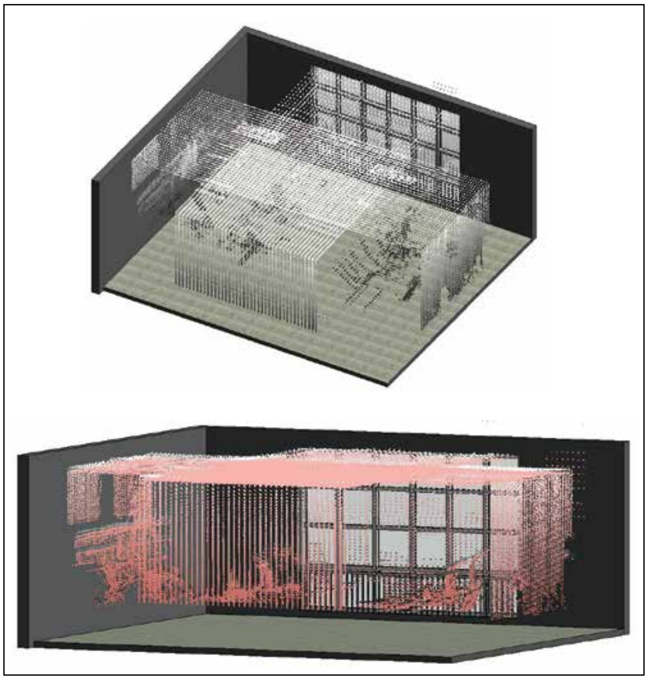

Figure 14. Scan results integrated with BIM design model

for SICK laser scanners. The main parameter values including 2D axial coordinates and intensity were extracted from the acquired scan results through a MATLAB-based algorithm. For the motion trajectory, a step length and heading estimation based on Pedestrian Dead-Reckoning (PDR) algorithm was applied in order to determine relatively accurate positions of laser scanner at each time interval point (the time interval was 1 second) (Kang, et al., 2012; Ruiz, 2017). Then each position was matched with the corresponding scan data at the same time point. Eventually, when all the extracted scan results were combined with the positioning trajectory measurements, 3D point clouds were formed as shown in Figure 9 and Figure 10. Here the quality of produced 3D point clouds depends on the combination level of 2D scan data with positioning trajectory and the accuracy of positioning measurements (Randall, 2011).

The next step is to import the scan point clouds into BIM tools. The objective of this step is to realize the integration of real site conditions with BIM design models for indoor mapping and discrepancy inspection. In this research, Cyclone and Autodesk Recap were used to implement the import of point clouds into Autodesk Revit (Tang, et al., 2010). Figure 11 and Figure 12 respectively display the processed point clouds in Cyclone and Recap. Figure 13 shows the initial BIM design model of the computer room, which was created in Revit before.

After the integration, it can be seen from Figure 14 that the indoor conditions above the ground 0.7m are almost reproduced (except the corners), and the scan profiles of room elements including windows, walls and ceiling, roughly match their dimensions in the BIM design model. However, there are still some discrepancies between the scan results and the design. These discrepancies may result from the errors which occurred during the experiment and later data processing, or the alterations in the actual construction phase of the room.

Outlook

For this research, although the experimental results indicate that the IMU-GPS system is applicable for indoor positioning, other advanced localization methods need to be experimented as they may highly improve the positioning accuracy and minimize measurement errors, even if the cost will also rise. Ultra-Wide Band (UWB) system can be another appropriate option due to its high performance for indoor applications (Belakbir, et al., 2014). Furthermore, limited by equipment and site conditions, the scan was not panoramic, which means the results did not provide a complete scan of the entire room. If high-quality 3D point cloud comparisons between existing buildings and designs are anticipated, we will need to improve the scan method to realize a panoramic scan of the indoor conditions, maybe both wheel-platform and handheld scanning methods will be experimented (Zlot, et al., 2014). In addition, as several software currently are used for the data transfer from scan to BIM tools, the data processing is complex and should be simplified to meet the requirements of large-scale indoor scan applications. Meanwhile, a common interface will be provided for the contrast between scan point clouds and BIM models in order to determine discrepancies, which are concerned about particularly for the quality control of as-built construction.

For this research, although the experimental results indicate that the IMU-GPS system is applicable for indoor positioning, other advanced localization methods need to be experimented as they may highly improve the positioning accuracy and minimize measurement errors, even if the cost will also rise. Ultra-Wide Band (UWB) system can be another appropriate option due to its high performance for indoor applications

Conclusion

Although there are some weaknesses existing in this novel laser scanning method, the experimental results still indicate a good feasibility and potential of its application in indoor digital mapping. Compared with stationary 3D laser scanning technologies, this method shows mobility, flexibility and other advantages including cost and time saving.

As the quality of final 3D point clouds acquired from this method depends on the combination level of 2D scan data with positioning trajectory and measurement accuracy, errors caused by the IMU-GPS system may impact the final experimental results in this research. Therefore, better indoor positioning methods such as UWB system will be applied in further relevant studies to improve the overall performance of this indoor mobile laser scanning method (Tappero, et al., 2009). More tests will be run in narrow and complex indoor environments to prove the reliability of this method. It is also expected that the BIM integrated with this method will make the quality controls of as-built constructions, the indoor mappings of existing buildings and the restorations of historical heritages more digital, more efficient and more reliable (Zlot, et al., 2014).

Acknowledgement

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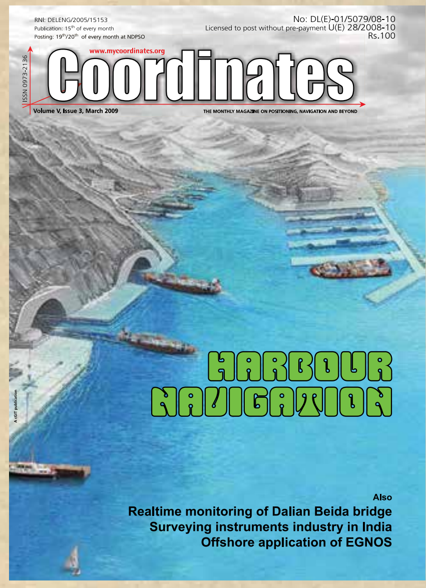
In Coordinates

10 years before...



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Harbour navigation

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Certain emerging navigation performance requirements for maritime applications are challenging to satisfy using systems available today. Very stringent performance requirements have, in particular, been identified for port areas, and cover aspects including service robustness, accuracy, integrity and availability.

One promising answer may be to augment GPS coverage with a groundbased Harbour Navigation System. In the Spring of 2008 EADS Astrium demonstrated a prototype for such a System, using transmitters based on navigation Pseudolite technology.

This paper focuses on the potential for a Harbour Navigation System to augment GPS for harbour operations. The paper wasderived from several recent publications [1-4] by the same author and colleagues from Astrium's Portsmouth offices.

Real time monitoring of Dalian Beida Bridge

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There are many traditional surveying methods used for the large-scale bridge structure deformation monitor such as the accelerometer measure, the total station surveying and the laser collimation, but these methods are limited by its function of which the continuity, timeliness and automaticity can not meet the need of the large-scale construction dynamic monitor. In recent years, with the GPS hardware and software technology developed, especially the GPS receiver with the high data-collection frequency (for example 10Hz even 20Hz[1][4]) appearanced as well as the GPS data processing was improvement, the GPS-RTK technology applied in large-scale bridge dynamic deformition monitor with real-time or quasi-realtime has become true[2][3]. Further, with the Fourier transformation tool the bridge base frequency could be obtained, the data of bridge vibrational state in spatial frame and frequency range distributed characteristic may provide the key to understand whether the bridge structure is health under the load drive environment.

Offshore application of EGNOS

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Today there are more than 300 helidecks in the UK sector alone being serviced by regular flights. Approach options in Instrument Meteorological Conditions (IMC) are limited to using the aircrafts' weather radar to identify the rig. This is neither designed nor certified for the task and following a UK Civil Aviation Authority (CAA) review the need for an accurate and reliable instrument approach aid for conducting offshore approaches has been highlighted.

With support from the UK CAA, the GNSS Supervisory Authority's (GSA) GIANT project has sought to develop a new approach procedure based upon SBAS guidance, in this case EGNOS.

GNSS/Geomatics education – Prospects and challenges

Issues related to GNSS jamming, interference and spoofing continues to be an important area to be investigated

Prof Luiz Paulo Souto Fortes
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Geosciences, along with many other professional fields, have been deeply impacted during the past couple of decades by a quick and broad technological evolution, which has been responsible not only for the replacement of classical measurement methods (e.g, from geodetic triangulation to GNSS surveying), but also for the birth of new applications, like study of vertical crust movements in the Amazon due to the seasonal hydrological cycle in the region.

This evolution can be especially noted in the context of Geodesy, with the current accurate measurement and analysis of the lithosphere, hydrosphere and atmosphere. Hence Geodesy can be defined nowadays as the science to study the shape of the Earth, its orientation in space, and its gravity field, as well as the changes of these properties with time. This scenario has led Geodesy to be considered one of the sciences to measure global climate change. Many tools have made this possible, most of them based on Satellite Geodesy, like Satellite Laser Ranging (SLR), Very Long Baseline Interferometry (VLBI), Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS), Satellite Gravimetry and the Global Navigation Satellite Systems (GNSS). The Global Geodetic Observing System (GGOS), of the International Association of Geodesy (IAG), is an initiative to provide the geodetic infrastructure necessary for monitoring the Earth system and global change research.

This fast technological evolution scenario brings a challenge to educators, as students need to be taught and learn subjects that could support their understanding and use of methods and technologies that are going to be available only a few years after they finish their undergraduate courses. So, it is more important than ever to help students to build a solid theoretical/conceptual background in all subjects, especially Mathematics, Physics, Geodesy, Remote Sensing, and Digital Mapping, in order to allow them to fully explore themselves new technologies that will show up in the future. Additionally, a solid knowledge in information technologies tools is very desirable. And considering that we live in a more and more globalized world, ability in English language is a must for students from countries that do not have this language as their native one.

In terms of career opportunities, it is worth to recall Gewin´s comment in "Naturejobs" section of Nature´s Jan 22, 2004 edition (http://www.nature.com/nature/journal/v427/n6972/full/nj6972-

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376a.html) about the US Department of Labor identifying geotechnology as one of the three most important emerging and evolving fields at that time, along with nanotechnology and biotechnology.

Since then it has been possible to witness several technological developments which are giving users access to new capabilities in terms of positioning and imaging, confirming the above prognosis. Smartphones that allow users to get pseudorange and, in some cases, carrier phase observations, along with dual frequency GNSS chips; the availability of new GNSS systems, like Galileo and BeiDou, to be completed around 2020, transmitting improved signals, making possible to have up to 40 satellites in view - meaning more measurements, better satellite geometry and thus better accuracy and reliability, with these advancements coupled with observations transmitted in real time by continuous operating GNSS networks in some countries, will literally put in non-specialized users hands the necessary tool to measure positions with up to centimeter level accuracy. Drones, using navigation and attitude sensors along with visible and non-visible imaging cameras and even LiDAR, being used in many geomatics applications, are other good examples of new tools which are requiring more and more professionals to develop, teach and properly use them. This situation creates a positive scenario for the geomatics profession currently and in the future.

In spite of that, it is possible to hear some colleagues worried about the future of the profession, as “new technological tools could replace us”. In this case, one should compare it with the medicine profession - even with the huge amount of information on diseases, drugs and treatments available on internet nowadays, it is not recommendable to anyone to decide not to see a medical doctor when getting ill! In the same way, a geomatics engineer needs to be involved in any project where positioning (with all ranges of accuracy) and mapping is implicitly or explicitly required. As an example of the importance of this, one can mention a dangerous accident with an underground gas pipe in São Paulo, Brazil, in 2001, hit by a construction machine guided by a GPS sensor, as the pipe was shown in a map using a reference system other than WGS84!

In terms of research, in addition to the advancement topics mentioned previously, issues related to GNSS jamming, interference and spoofing continues to be an important area to be investigated, considering the very broad and increasing use of GNSS sensors everywhere.

Funding is used to be a critical aspect in any research or project, especially in developing countries. This aspect may get worse during periods of economic recession, which affects all sectors of society, including the academic sector. In all circumstances, cooperation with the industry can be beneficial for both the industry and the academy, making the development of research projects viable and applicable.

TCarta wins contract to Map Seafloor around Kiribati

TCarta Marine has been contracted by the United Kingdom Hydrographic Office (UKHO) to provide a baseline dataset of water depths and seafloor classification around the Republic of Kiribati. Located in the Pacific Ocean, the island nation is threatened by rising sea levels.

TCarta won the open bid for supply of Satellite Derived Bathymetry (SDB) to the UKHO to extract water depth measurements and seafloor classifications, including habitat types, from multispectral satellite imagery. In this project, it is processing eight-band DigitalGlobe WorldView-2 and -3 data predominantly, as well as four-band WorldView-4 and GeoEye-1 data to measure depths down to 30 meters at a resolution of two meters.The Kiribati nation is comprised of 33 atoll islands and multiple reefs spread over an area of the Pacific Ocean nearly the size of the Continental U.S. Multiple new reefs have been discovered by TCarta using this satellite derived approach at the start of this project. *www.tcarta.com*

Esri to Chart the Waters of Denmark and Greenland in partnership with GST

Esri has partnered with the Danish Geodata Agency (GST) to implement a modern workflow to more efficiently create and maintain nautical charts of Danish and Greenlandic waters. It will assist with the installation of, and training for, the new enterprise production system. Because maritime traffic is increasing significantly and new routes are opening due to melting ice, it is crucial to have accurate charts in support of safe navigation and environmental protection.

GST turned to Esri for a solution when the organization needed to convert the production of navigational charts from a file-based system to a database and to combine cross-agency chart production into one inclusive system. GST expects to reduce the time it takes staff to produce charts of all Danish waters and enable them to share information across departments and multiple agencies. *esri.com*

Ordnance Survey to launch mapping drone

National mapping agency for Great Britain - Ordnance Survey (OS) has announced plans to launch a solar-powered drone that will fly at high altitude to complement existing satellite mapping systems. The aim of the High Altitude Psuedo Satellite (HAPS) project, called Astigan, is to provide faster, higher quality images of Earth from 67,000 ft – almost twice the cruising altitude of a commercial airliner. The platform weighs just 149kg and has a wingspan of 38 meters. Much like Airbus' record-breaking solar-powered drone, the intention is for Astigan to be a middle ground between conventional satellite systems and your average UAVs. Eventually, it will fly for 90 days at a time without needing to land – enough time to circle Earth four-and-a-half times. *https://dronelife.com*

EU invests over £10bn in innovative clean technologies

The Commission has announced an investment programme worth over €10 billion for low-carbon technologies in several sectors to boost their global competitiveness. Innovative climate action has a range of benefits for the health and prosperity of Europeans with an immediate, tangible impact on people's lives – from the creation of local green jobs and growth, to energy-efficient homes with a reduced energy bill, cleaner air, more efficient public transport systems in cities, and secure supplies of energy and other resources.

The Commission wants to ensure that Europe continues to be at the top of the league as regards new high-value patents for clean energy technologies. This leadership provides a global competitive advantage, allowing Europe to harvest first mover benefits by increasing exports of European sustainable products and sustainable technology and business models. On 28 November 2018, the European Commission adopted a strategic long-term vision for a prosperous, modern, competitive and climate neutral economy by 2050 – A Clean Planet for all. *https://ec.europa.eu*

Drone based survey for land records in Karnataka, India

The Karnataka government and the Survey of India have signed a Memorandum of Understanding to use drones to do land surveys and help people and farmers in particular, get more accurate land records in a shorter time. The survey was intended to not only remove human errors in the preparation of land records, but also eliminate manipulation of boundary lines. Happy with the success of the pilot tests conducted in Jayanagar 4th block in the city and Ramanagar using drones, the Karnataka government now intends to use drones to prepare land records all over the state. In the first phase, drones will be used to do surveys in Hassan, Ramanagara, Tumakuru, Uttara Kannada, Belagavi and Bengaluru city over a period of about two years and in the second, it will be extended to Vijayapura, Kodagu, Dharwad, Dakshina Kannada, Mysuru, Gadag, Davangere and Kalaburagi. *www.deccanchronicle.com*

BIM workflows to design iconic station for Indian Railways

Voyants Solutions Private Limited has been selected to design an iconic new Gwalior Railway Station that would complement the existing station and attract tourism. The firm used BIM models and workflows to optimize building design and incorporate existing structures. The company designed a structure and development plan that specifically accommodated the challenging requirement of keeping the existing station fully operational during construction. *www.bentley.com*

Mapping underground infrastructure in NYC

Geospatial Corporation is providing engineers and utilities in the New York metropolitan area with accurate maps of buried pipelines and conduits under busy streets and deep waterways. These maps allow the engineers installing new cables to more accurately calculate the geometry and bending radius along multiple runs of buried pipelines and conduits regardless of the material of the line. The acquired data is critical to allow the engineers to calculate the pulling force necessary to install new cables without damaging the cable. The company's team of data collection specialists has completed multiple projects in New York City. An example of some of the completed projects are the mapping of 7315 m of electrical cable in Queens; the mapping of a communication conduit crossing the East River, and the mapping of an electrical conduit under the Harlem River. The accurate location data helps clients avoid costly mistakes during installation. GeoUnderground allows users to accurately record and manage the location and depth of buried infrastructure. *www.GeospatialCorp.com*

Re-establishing oyster beds to maximize their ecological benefits

Researchers from North Carolina State University have developed a mapping tool that identifies sites for re-establishing oyster reefs that maximize their ecological benefits -- such as water filtration. This GIS-based tool could inform restoration of other vital, sensitive coastal habitats.Theuerkauf and NC State colleagues David Eggleston, professor of marine sciences, and Brandon Puckett, former NC State Ph.D. student and current research coordinator for the NC Coastal Reserve, utilized GIS tools to develop a model that could predict the best locations for oyster bed reestablishment that would provide maximum likely water filtration benefits. The researchers developed three versions of their model: one that identified areas where oyster restoration yielded maximum water filtration benefits; one that identified areas that would best sustain the overall oyster population; and another that identified areas with a balance between water filtration and population enhancement. *www.sciencedaily.com*

End-to-end GIS solutions

Schneider Electric, a GIS solutions for utilities and communication providers, has named RMSI North America, an IT services company providing geospatial and software solutions, an ArcFM Specialised Partner. RMSI's data solutions and migration expertise will offer customers a choice for their data needs as they prepare to implement Esri's new Utility Network Management Extension. *www.schneider-electric.com*

Terra Drone launch its India operations

Terra Drone Corporation has ventured into the Indian market with the establishment of Terra Drone India. With its headquarters in Japan and presence in Asia, Africa, Europe, North America and Latin America, Terra Drone is one of the largest industrial UAV companies in the world. Its associate company, Terra Drone India will offer localized drone solutions to both the public and the private sector in India. *www.terra-drone.net*

Unifly partners with Terra Drone India to support UTM in India

Unifly NV has entered into an agreement with Terra Drone India Pvt. Ltd., an end-to-end drone solutions provider, to facilitate the safe integration of unmanned aerial systems (UAS) into the Indian airspace. Unifly's automated air traffic management system combines technologies like flight planning, airspace approval, live tracking of UAS, and dynamic situational awareness, to handle a large number of drones flying in the most challenging environments. These are the capabilities that India's Directorate General of Civil Aviation and the Ministry of Civil Aviation require to actualize Digital Sky Platform, the most advanced drone control platform in the world.

DJI Improves enterprise drones

DJI has unveiled new hardware and software tools to give professional drone operators improved control, safety, and security for high-stakes missions. The new Matrice 200 Series V2 drones are redesigned with better reliability, safety, and security features, while the FlightHub drone operations management platform gives organizations more implementation control and data security assurances. *www.dji.com*

Atmos UAV expands its camera options and launches new software

Drone company Atmos UAV has just expanded its camera options. Its engineering team optimally integrated additional cameras that are now available for their customers. Furthermore, the team also launched the newest version of MarLynk, the flight planning and ground control software provided with every Marlyn unit.

To further satisfy the customers' needs for ever higher accuracy, ATMOS UAV extended its camera options to include the RGB Sony RX1RII Full Frame camera and the new MicaSenseRedEdge-MX, on top of the Sony QX1 it currently carries. *www.atmosuav.com*

Measure introduces Ground Control 2.0

Measure launches its next generation drone software platform, Ground Control 2.0. Version1.0 was launched last year with an easy-to-use flight application developed specifically for commercial use and a cloud-based web portal where managers could check airspace and view flight logs and data screen shots automatically uploaded from drone missions. *www.measure.com*

Anti-drone technology enters African market

US company Department 13 has licenced Skydrone to represent its Mesmer anti-drone product in the African market. Mesmer is a patented drone mitigation solution which is low power, non-jamming, non-line of sight, and non-kinetic. It provides a safe and effective method of protecting personnel and infrastructure from dangerous drones.

The technology prevents drones from physically harming people, damaging and disrupting critical infrastructure, and stealing intellectual property, because of the risk that drones pose. Mesmer detects unauthorised drones, identify them, and neutralise them by taking control of them and then either sending them back to their pilot or landing them safely. This is different to signal jammers that have traditionally been used, but which can cause drones to fall from the sky onto people. As it is built on open source software architecture, it can be seamlessly integrated into existing security and surveillance systems. *www.skydronetech.co.za*

IN-FLIGHT Data awarded three GUINNESS WORLD RECORDS™

IN-FLIGHT Data, one of Canada's leading commercial drone operators, has been awarded three GUINNESS WORLD RECORDS™ for drone (UAS) flights recently carried out as part of a groundbreaking BVLOS project with help from senseFly.

- Three world records for flights carried out during the innovative Canadian project included
- Longest cumulative beyond visual-line-of-sight battery-powered UAV flight: 2,723.04 km (Alberta)
- Longest cumulative urban flight for a beyond-visual-line-of-sight civilian UAV (small class – up to 25 kg): 414 km (Calgary)
- Longest single urban flight for a beyond-visual-line-of-sight civilian UAV (small class – up to 25 kg): 40km (High River)

The GUINNESS WORLD RECORDS™ were awarded specifically for BVLOS flights conducted in Calgary, Alberta, which saw the City of Calgary commission IN-FLIGHT Data to collect mapping data for the development of Calgary's first new cemetery since 1940.

Drone delivery location verification system by Amazon

An Amazon patent recently published online entitled "Drone Marker and Landing Zone Verification" reveals the system the company might use both for guiding delivery drones to their destination and for verifying that the location where a delivery is made is the correct one.

The system described in the patent looks like it would be able to recognize landmarks at a package recipient's address, which could help verify the recipient's location. The system could also spot obstacles to the delivery, such as a grill, a basketball, or tree branches (examples taken from an image included in the published patent). Detection of obstacles like these would trigger the system to send a message to the recipient's mobile device asking him or her to remove the obstacle.

Delair launches aerial intelligence platform

Delair has unveiled Delair Aerial Intelligence (delair.ai), a comprehensive platform for converting drone-based images into actionable business insights.

The new cloud-based solution provides a complete integrated and easy-to-use workflow to manage, analyze and share data, streamlining the process for unlocking the true potential of aerial surveying. Industry-optimized analytics for specific industries and use cases in mining, quarries, construction, power and utilities, and agriculture enable more accuracy and precision to deliver bottom-line benefits to a wide range of businesses.

Cyient – BlueBird joint venture launches its new UAS

Cyient Solutions & Systems has launched its latest offering, the WanderB Vertical Take-Off & Landing (VTOL) Unmanned Aerial System. It is an exciting and technologically advanced solution for military, peacekeeping, low-intensity conflict resolution, law enforcement, disaster management, and commercial applications.

The VTOL feature makes the WanderB a versatile solution for both land and maritime operations. As a fully autonomous UAS equipped with two batteries, the VTOL can operate even in strong winds and harsh weather conditions. *www.cyient.com*

Wind lidar measurements from a drone

Lidar developer, ZX Lidars, has demonstrated the use of drone wind lidar for vertical and horizontal profiling to accurately measure wind conditions remotely and above or ahead of their installed position. These accurate, independent wind measurements are a cornerstone in the development, construction and operation of wind farms globally.

The company has now achieved accurate wind lidar measurements from a commercially-available unmanned aerial vehicle (UAV) for demonstration purposes, and tested the system successfully with good data rates and sensitivity. A number of ZX Lidar systems are available for testing in this or similar applications. *www.zxlidars.com*

Get real-time data on methane leaks safely

The second-generation Laser Methane Copter by SPH Engineering and PERGAM transfers high-precision data on the go. This solution answers the need for a safer ready-to-use drone-based detecting system for every company that produces, transfers or uses methane. Natural gas pipeline surveys, tank inspections, landfill emission monitoring, gas well testing, plant safety audits — there are many applications for Laser Methane Copter. LMC G2 is a second-generation product and is the latest creation of PERGAM. *UgCS.com*

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I, Sanjay Malaviya, hereby declare that the particulars given above are true to the best of my knowledge and belief.

March 1, 2019 Signature of publisher

Microsatellite contract to Space Flight Laboratory

The Canadian Department of National Defence has awarded a C$15 million contract to Space Flight Laboratory (SFL) at the University of Toronto Institute for Aerospace Studies (UTIAS) for development of multipurpose microsatellites to support Arctic surveillance. Upon successful completion and testing of the prototype, two additional microsatellites will be built to create a small formation.

The UTIAS SFL microsatellites being developed will include multiple sensors on a constellation of microsatellites operating in close formation in low Earth orbit to allow for quick and timely detection and identification of surface or airborne targets. These concurrently-obtained sensor observations are expected to improve the reliability of the detection and identification performance, which is not feasible when individual sensors are located on non-collaborating satellites. *www.utias-sfl.net*

Vietnam aims to master remote sensing satellite manufacturing technology

Vietnam is expected to master the remote sensing satellite manufacturing technology under the national remote sensing development strategy to 2030 with a vision towards 2040, recently approved by Prime Minister Nguyen Xuan Phuc.

The country also aims to widely apply remote sensing technologies and use remote sensing products and data in various sectors, especially in natural resources and environmental supervision, search and rescue operations, natural disaster combat, and climate change response. The strategy also sets the target of building stations to collect and handle the database on national remote sensing photos in service of socio-economic development, as well as national defence and security.

To that end, the country will perfect remote sensing-related institutions, policies, laws, and technical standards, while also enhancing state management capacity in this regard. Under the strategy, data management agencies will enhance coordination as well as information, data, and product sharing with related ministries, agencies, localities, organisations, and individuals. *https://en.vietnamplus.vn*

FARO® Introduces BuildIT 2019 Software Platform

FARO® has released the advanced BuildIT 2019 software suite. It represents the logical evolution of the industry-proven BuildIT platform, which has povided exceptional value across a variety of industries. It offers three individual products, each specifically designed for quality inspection, manufacturing and assembly or construction applications. Each product includes the most flexible and intuitive user interface in the industry. It is tightly integrated with FARO® hardware and non-FARO hardware products. *www.faro.com/in*

Iran promotes using remote sensing satellites in agriculture

According to a recent agreement signed between the Iranian Space Research Center and the Ministry of Agriculture, remote sensing satellites are planned to be used in different sections of the agricultural industry.

The center already provided a map of cultivated area, which provides more than 95 percent of national rice market in five provinces, he added. The space-based business and startups can give consult to farmers in order to modify their cropping pattern and farm management, which leads to improvement of their harvest and increase its quality. *www.tehrantimes.com*

Satellite imagery for monitoring the forest cover

Accelerating its efforts to save forest lands from encroachments, the Government of Telengana, India has decided to utilise satellite imagery for continuously monitoring the forest cover. The State has accordingly roped in the National Remote Sensing Agency for providing high resolution satellite images to enable it to keep a tab on encroachments, if any, in the forest areas.

The State has been depending on the biennial reports of the Forest Survey of India that provide details of change in the vegetation cover State-wise till recently, but two years is too long a period in view of the utmost priority accorded for preservation of forest cover by Chief Minister K. Chandrasekhar Rao. Accordingly, the project has been taken up on experimental basis in Bhadradri-Kothagudem and Bhupalpally districts, known for vast extent of forest lands.

Based on the results of the pilot project, the Government will extend the project to all districts with forest cover subsequently. Though the department initially explored options for deploying high resolution satellite imagery with 1m resolution available, it was decided against these technologies owing to “lot of costs” involved in it. *www.thehindu.com*

Ancestral structures in Colorado identified using drone based LiDAR system

Culturally rich Canyons of the Ancients National Monument, Colorado, is managed by Bureau of Land Management as an integral cultural landscape containing a wealth of historic and environmental resources. The Monument holds the distinction of having the highest density of archaeological sites in the USA. Most of these sites represent Ancestral Puebloan and other Native American cultures. Local Crow Canyon Archaeology Center and the Canyons of the Ancients National Monument have worked at Sand Canyon, an ancestral Pueblo site in the area, for over 20 years. They required improved ways to better visualize the site to inform ongoing preservation. A recent UAV LiDAR survey provided impressive results to accelerate understanding.

Locally based in Durango, Colorado, USA, Caddis Aerial are seasoned land surveyors who provide professional drone survey services across the Four Corners. The team implemented Routescene’s rigorous survey workflow starting with survey and project planning. Once on location, the team established ground control and undertook a reconnaissance of the site. Deploying the Routescene LidarPod, flown using a DJI M600 Pro, the drone executed its' flight plan and returned to the take off point after each flight. Three flights were performed to cover the entire site, each flight took 10 minutes, and a total of 24 flight lines were flown to ensure 100% data overlap.

During the survey itself, marshals were stationed to ensure members of the public did not enter the survey site. The LidarPod operators monitored in real-time in-flight the quality of the data being collected using Routescene's QA Monitor software. More than 3.2 billion points were collected during this survey and it was important the high resolution of the data was maintained during analysis. Using their proprietary software, LidarViewer Pro and their Bare Earth tool, Routescene extracted the bare earth points to create a bare earth terrain model.

Although the Sand Canyon Pueblo was studied, mapped, and excavated between 1984 and 1995 using traditional survey techniques, the Crow Canyon Archaeological Center required much more detailed, high resolution data and could instantly see the value of performing a UAV LiDAR survey on the site. *www.routescene.com*

The US government might charge for satellite data again

Landsat is one of the most important U.S. satellite systems. Since the program's launch in 1972, Landsat satellites have provided the longest-running terrestrial satellite record and collected more than 5.6 million images.

For a long time, the U.S. government charged a fee for every Landsat image. But this changed on Oct. 1, 2008, when the U.S. Geological Survey opened the Landsat archive and made it free for everyone to use.

This open data policy has led to a dramatic increase in the use of Landsat data. Studies have used Landsat data to map global forest loss, surface water extent, human settlements and land cover, among other features.

However, the free and open Landsat data policy is now under scrutiny. An April 2018 news report revealed that the Department of the Interior was considering putting a price on Landsat data again. The decision may come sometime this year.

This potential policy change is concerning. For the Landsat program to remain successful, free and open data is the key.

The U.S. is a global leader in the collection and application of Earth observation remote sensing data. Open access to Landsat, as well as other satellite data, has become the norm.

Officials at the Department of the Interior are exploring the possibility of recovering some of Landsat's operation costs from users. This is understandable. However, if Americans want to continue enjoying its societal benefits, then the data needs to remain free and open *The Associated Press*

B4UFLY Mobile App Update

The Federal Aviation Administration (FAA) has partnered with Kittyhawk to redevelop B4UFLY, the FAA's first mobile application, to improve the user experience so that recreational drone operators know where they can and cannot fly.

The current B4UFLY App will continue to be available to the public until the new App is deployed. The data reflected in the current App will continue to be updated regularly, but no new features will be added.

The FAA and Kittyhawk plan to launch the new App in 2019. Kittyhawk is an enterprise drone operations software company that has been an FAA Low Altitude Authorization and Notification Capability (LAANC) UAS Service Supplier since October 2018. *www.faa.gov*

Queen Elizabeth Prize for Engineering for GPS pioneers

This year's £1m QE Engineering Prize has been won by four individuals who played key roles in developing GPS. The Americans Brad Parkinson, James Spilker Jr, Hugo Fruehauf, and Richard Schwartz were all present at the London ceremony held to announce the honour.

Dr Parkinson said it was an extraordinary honour to receive the Queen Elizabeth Prize for Engineering, but he was then quick to pay tribute to the many people who were involved in the innovation. "It is an awesome honour. There is no prize for engineering greater than this," he told BBC News.

He pulled together experts over Labor Day weekend, 1973, to brainstorm the project, producing a 7-page report that was then implemented with initial funding of $200m. Dr Parkinson recruited James Spilker Jr, who designed the signal that's transmitted by the satellites.

Hugo Freuhauf is credited with miniaturising laboratory atomic clocks so they could be carried aboard a spacecraft. These small, super-accurate timepieces are at the heart of the system.

And Richard Schwartz takes a share in the prize for the radiation-hardened design of the satellites, which at the start of the project were made by Rockwell International. *www.bbc.com*

UK Galileo replacement proposed

In a paper published in the Journal of Electrical and Electronics Engineering, Professor Chris Chatwin of the University of Sussex and Dr Lasisi Lawal Salami from the Obasanjo Space Center in Nigeria put forward their aim to provide an alternative to Galileo, which is set to launch in 2026. The proposal comprises a Satellite-Based Augmentation System (SBAS) to be hosted by a national satellite as a Navigation Overlay Service (NOS); academics say it would cost around £300 million (€344.52 million) and would fulfil the UK's satellite navigation needs in the defence, aviation and maritime sectors, as well as providing essential location-based service information for the emergency services.

The programme laid out in the proposal, including the launch of three geostationary satellites to allow for global navigational coverage, an augmentation system acting as a payload on a national satellite and on-ground infrastructure to support the satellite system, is projected to take a year to complete. The paper suggests the programme would provide up to five times more accuracy than Galileo and reach equivalent levels of integrity and reliability.

Professor Chatwin, Professor in Engineering at the University of Sussex, said: "Our system can use the GPS or Galileo free signal or both and augments it to give it a more accurate signal that is comparable to the encrypted military signal. The augmentation system has extremely accurate clocks so it provides an additional signal to the GPS signal and reduces the ambiguity of the location determination. If we use augmentation we can greatly reduce costs from £7 billion to £300 million, but we still depend on the US or the EU for their free signal.

In the end this is a decision about sovereignty. If we still believe that we are an independent military power, then we'd have to find considerable resources to build our own GNSS [global navigation satellite system]. We could call it Newton." *www.governmenteuropa.eu*

Jamming of GPS signals in Norway

Norway's foreign intelligence unit has expressed renewed concerns that its GPS signals in the country's Far North were being jammed. In its annual national risk assessment report, the intelligence service said that in repeated incidents since 2017, GPS signals have been blocked from Russian territory in Norwegian regions near the border with Russia. The jamming events have often coincided with military exercises on Norwegian soil, such as the NATO Trident Juncture manoeuvres last autumn and the mid-January deployment of British attack helicopters in Norway for training in Arctic conditions.

Norway has on several occasions raised the issue with Russian authorities, and is cooperating with other Nordic countries to gather as much information as possible, Defence Minister Frank Bakke-Jensen said. *www.france24.com*

India to launch GLONASS-based transport control system

India is going to launch a toll collection system based on Russia's GLONASS on New Delhi-Mumbai highway. The project will be implemented by the operator of Platon Electronic Toll Collection (ETC) system, which is used to collect tolls from the owners of heavy lorries in Russia.

Russian RT-Invest Transport Systems (RTITS), the operator of GLONASS-based Platon ETC system, received a contract for the implementation of a similar project in India.

RTITS, which is co-owned by Russian billionaire Igor Rotenberg, won the tender and signed the contract with India at the end of December 2018. The company has already begun the implementation of a fare payment system on the New Delhi-Mumbai highway with a length of almost 1,500 kilometres.

To implement the system, it is supposed to equip vehicles with onboard devices based on GLONASS and the Indian Regional Navigation Satellite System. The devices have been developed specifically for this project. The Indian transport sector expects to earn up to $2-3 billion per year thanks to the toll collection system. *https://realnoevremya.com*

China to launch 10 BeiDou satellites

China will send 10 satellites to join the BeiDou Navigation Satellite System (BDS) through seven separate launches this year, the China Aerospace Science and Technology Corporation (CASC) has announced. The launches will help complete the BDS global network by 2020, said Shang Zhi, director of the Space Department of the CASC, at a press conference, where the Blue Book of China Aerospace Science and Technology Activities was released. As an important achievement during the past 40 years of reform and opening-up, the BDS has also been widely used to serve China's economic development.

More than 6,000 fishing boats in the eastern province of Zhejiang have been installed with the BDS ship movement monitoring system, which helps them improve positioning accuracy and promptness.

About 6.17 million vehicles, 35,000 postal and express delivery vehicles and 80,000 buses in 36 major cities have been installed or are compatible with the BDS. The system is also used in homemade civilian aircraft.

China Post has equipped its postal vehicles with 30,000 BDS terminals and connected them with the BDS-based information management platform. E-commerce giant JD.com also arms 1,500 logistics vehicles and 2,000 couriers with smart BDS terminals, according to the blue book. *www.xinhuanet.com*

Galileo now predicts the weather

Spire Global, a space-to-cloud analytics company, is now using Galileo to offer GNSS radio occultation (GNSS-RO) products for the weather community. Radio occultation is the process of using satellites to measure how GNSS signals are refracted by the Earth's atmosphere.

Two of Spire's nano satellites are the first to use Galileo signals to measure GNSS-RO profiles, a service now available to Spire's global user base as a new tier of data for advanced weather prediction. The satellites were launched on Nov. 29, 2018, from Sriharikota, India. The satellites are part of the collaborative European Space Agency ARTES Pioneer Space-as-a-Service program, which aims to prove the value of using nanosatellites for space-based GNSS-RO.

With Galileo, Spire's weather observation satellites can harvest approximately 25 percent of the total GNSS-RO profiles available from the existing GNSS satellite constellations in orbit today.

Transformation in autonomous marine operations using robotic arm

Marine-i, the EU funded programme set up to boost marine innovation in Cornwall, has made a grant award to specialist marine technology company, Submarine Technology Ltd (STL). STL has opened a new office in Penryn, Cornwall, UK, to focus on designing and building their futuristic robotic arm, which is a ship-based multi-axis robotic arm for autonomous operations. It will form an integral part of a new Autonomous Synchronised Stabilised Platform (ASSP) to enable intervention tasks to be carried out from Autonomous Surface Vessels (ASV).

Typical intervention tasks will include equipment transfer and payload management, survey and inspection, & launch and recovery. In the future, ASVs will play an important role in the inspection, servicing and repair of offshore wind farms and other renewable energy technologies.

Luokung Technology Corp. announces cooperation with China-LBS

Luokung Technology Corp. a leading interactive location-based services company in China, has announced its strategic partnership with Beidou Navigation and Location Service (Beijing) Limited ("China-LBS"), which is the builder and operator of Beidou Navigation and Location Service Industrial Public Platform. The partnership aims at providing a leading spatial-temporal big data platform service in the area of intelligent transportation to the Company's users.

China-LBS' platform has significant data resources in the navigation and location-based services industry, including aerial images data, satellite images data, digital elevation models, vector topography, geographical names database, navigation electronic maps, nautical charts and navigation channel charts, meteorological and hydrological data, users' location data of terminals. The platform also has significant shared bicycle tracks, transport and personal vehicle tracks in Beijing area. *www.luokung.com*

Stanford develops an AI navigation system

Stanford researchers are developing an AI-powered navigation system to direct spaceborne 'tow trucks' designed to restart or remove derelict satellites circling aimlessly in graveyard orbits.

There are zones in space, outside Earth's atmosphere, where old satellites go to die or, rather, to hang out … forever. Too high to burn up in the atmosphere, yet too slow to escape Earth's gravity, useless satellites are doomed to circle in what are called graveyard orbits.

Stanford professor of aeronautics and astronautics Simone D'Amico hopes to change all that.

His Space Rendezvous Lab (SLAB) is working with the European Space Agency (ESA) to spur development of an artificial intelligence system to direct the orbital equivalent of a tow truck. The two groups are hosting a competition for an AI system that would identify a derelict satellite and, without any input from Earth's assets, guide a repair vessel to navigate alongside to refuel, repair or remove it.

The software competition is one milestone in a broader research and development program that D'Amico says will feed into his lab's efforts to develop low-cost navigation systems that future spacecraft will use to maneuver toward distressed satellites or rendezvous with other cooperative satellites.

The navigation system that D'Amico has in mind would be inexpensive, compact and energy-efficient. To spot defunct satellites, the repair vehicle would rely on cameras that take simple gray-scale images, just 500-by-500 pixels, to reduce data storage and processing demand. Barebones processors and AI algorithms that come out of the competition would be integrated directly into the repair satellite. No ground communication would be required. The goal is simplicity: processors and algorithms that require low-resolution images and limited computation to navigate space. *stanford.edu*

Kontakt.io launches Simon AI

Kontakt.io, location Internet of Things (IoT) Infrastructure provider, has launched Simon AI, the location and sensor analytics software suite for safety and efficiency applications in operational environments. The application platform targets operational users in various verticals: from plant and warehouse managers, operation-, finance-, risk- and human-resource managers, mainly in small and medium-sized companies. *getsimon.ai*

Mobile mapping solutions by Indoor reality

Indoor Reality has released backpack and handheld indoor mobile mapping systems. The solution consists of two wearable hardware systems for data capture, which share a common SaaS (Software-as-a-Service) pipeline in order to:
create feature rich point clouds, and 3D CAD (Revit®) models for BIM and interactively visualize, and virtually navigate inside the photo-realistic 3D models via an intuitive web interface allowing for 3D tagging of objects, and dimension measurements. It also automatically locate assets and people inside buildings (Indoor GPS) *indoorreality.com*

Aceinna launches INS1000 for guiding autonomous vehicles

Aceinna is offering the INS1000 high-performance dual-band real-time kinematic inertial navigation system (RTK INS) with built-in inertial sensors for construction, agriculture and automotive applications. It has also launched an OpenIMU package for autonomous vehicle guidance and navigation.

Rightware and HERE reimagine the digital automotive user experience

Rightware and HERE Technologies announce the availability of Kanzi Maps, the new map renderer from Rightware, with fresh mapping data from HERE for evaluation and development by joint customers. The solution is available as a Kanzi Maps pre-release from Rightware and under a HERE Open Location Platform (OLP) evaluation license.

Trimble announces next generation mixed-reality device

Trimble has announced a new wearable hard hat compatible device that enables workers in safety-controlled environments to access holographic information on the worksite—the Trimble® XR10 with HoloLens 2. It is the first device created with the Microsoft HoloLens Customization Program and integrates the latest spatial computing technology into a certified solution for use with a hard hat for worker safety. With a wider field-of-view, improved usability and a unique, flip-up viewscreen, the Trimble XR10 with HoloLens 2 combines state-of-the-art mixed reality and safe operation in restricted access work areas. The full solution provides even greater accessibility to 3D models by front-line workers. *www.trimble.com*

Hexagon advances its 5D visualisation portfolio

Hexagon has signed an agreement to acquire Thermopylae Sciences and Technology, a software provider primarily focused on the U.S. government and defence market that specialises in geospatial applications, mobile frameworks, and cloud computing for enhanced location intelligence.

Thermopylae has developed advanced visualization solutions to support tactical edge mapping in support of mission critical operations. Built upon the Google technology stack, its defence and intelligence solutions are targeted at addressing the challenges involved in working with critical problem sets in secure or classified government environments. *hexagon.com*

iXE3 and iGW3 machine control solutions by Leica Geosystems

Leica Geosystems have released a new productivity tool for iXE3 and iGW3 machine control solutions based on SVAB's Quantum Tool Recognition system.

Tool Recognition is a wireless system that automatically detects the work tool that is used on a construction equipment machine via Bluetooth Low Energy (BLE). The system can automatically identify which work tools are connected to the machine.

The machine operator no longer needs to manually change settings in the Leica Geosystems machine control solution when changing work tools with this system; this is now an automated process. The driver will also get a warning if a work tool without a tool recognition module is selected.

Canadian coal company signs safety deal with Hexagon

Hexagon's Mining division has announced a significant safety solution deal with Conuma Coal Resources Limited ("Conuma"). The three-year subscription package will cover Conuma's three mines near Tumbler Ridge in northeastern British Columbia, Canada.

The Brule, Willow Creek and Wolverine mines employ about 800 staff and account for a fleet exceeding 180 pieces of equipment. *hexagon.com*

Rohde & Schwarz and Bluetest announce collaboration

Testing the antenna performance of GNSS signals such as GPS, GLONASS, Beidou, Galileo and MBS is key to location accuracy performance of a mobile device. To address the testing need for A-GNSS services, Rohde & Schwarz and Bluetest partner in creating test concepts for OTA antenna measurements. The two companies integrate the R&S LBS Server, a Software component running on the R&S CMW500 wideband radio communication tester, and the Bluetest OTA test solution for A-GNSS systems based on Bluetest's RTS65 reverberation chamber and Bluetest's Flow measurement software. *www.rohde-schwarz.com*

NavVis now uses SLAM

NavVis, the leading global provider of indoor spatial intelligence solutions for enterprises, announces a new software release for the NavVis M6 Indoor Mobile Mapping System (IMMS) that automatically detects and removes dynamic objects and object fringe points from point clouds during the post-processing of scan data. Fringe points and dynamic objects are two common types of point cloud artifacts that affect all 3D laser scanning devices. Fringe points arise when a laser beam hits the edge of an object as well as its background. This scattered beam ultimately appears as a so-called fringe around the edge of the object in the point cloud. The second type of point cloud artifact results when dynamic objects, such as humans walking through a scan, are captured by the laser scanner and then appear as artifacts in the point cloud. *www.navvis.com*

NovAtel's Firmware Version 7.05.04 release delivers NavIC L5 signals

NovAtel Inc. has announced the 7.05.04 firmware release for its OEM7 series family of receivers, and with this release NavIC L5 signals are now available on NovAtel OEM7 receivers.

The following key benefits are now available in the 7.05.04 release:

- Users can achieve a single point position accuracy of 2.5m (RMS) using NavIC L5 signals (from the Indian Regional Navigation Satellite System) with GPS L1 on the newly available JSN model
- Access to the L5 frequencies on the OEM7600 and OEM7720 provides triple frequency capabilities to unlock the potential of GPS L5, Galileo E5a and AltBOC, BeiDou B2a and NavIC L5

www.novatel.com

Trimble and Digi collaboration

Trimble has announced a collaboration with Digi International, a leading global provider of Internet of Things (IoT) connectivity products and services, to enable Trimble fleet customers to leverage the SmartSense by Digi® solution on their refrigerated trailers.

With SmartSense by Digi, fleets in the food and beverage industry can quickly deploy remote monitoring to improve productivity, compliance and quality control. Designed to deliver real-time insight, SmartSense provides an efficient subscription-based service that continuously and wirelessly monitors task management activities and the temperature of perishable, high-value goods in different industries such as food services, healthcare, transportation and logistics or retail.

Telit releases NavIC-enabled SL869T3-I GNSS module

Designed to support the Indian NavIC (formerly IRNSS) constellation L5 signal simultaneously with GPS L1 and SBAS, the Telit SL869T3-I GNSS module is the new multi-constellation member of the company's SL869 family of modules.

The SL869T3-I is equipped with special HW and SW to support navigation on L1 and L5 bands. It can navigate using GPS L1, IRNSS/NavIC L5 and the GAGAN L1 SBAS systems concurrently.

Topcon introduces new HiPer VR versatile GNSS receiver

Topcon has unveiled HiPer VR, the latest addition to its HiPer series of integrated receivers, aiming to provide a versatile solution with the most advanced GNSS technology available

The HiPer VR features Topcon integrated levelling technology (TILT) designed to compensate the inaccurate field measurements out of plumb by as much as 15 degrees. It is designed as a complete and versatile solution for a variety of applications including static or kinematic GNSS post-processed surveys, a network RTK option when paired with a field computer equipped with a cellular modem, a radio or LongLink job site RTK rover, as well as the GNSS component of the Hybrid Positioning and Millimeter GPS workflows.

Nurlink launches GNSS and NB-IoT system on chip

CEVA Inc. and Nurlink have introduced Nurlink's NK6010 3GPP Rel.14 eNB-IoT system-on-chip (SoC), powered by the CEVA-Dragonfly NB2 IP solution. NK6010 is a cost- and power-efficient NB-IoT system on chip (SoC) designed specifically to enable narrowband connectivity in massive internet of things (IoT) devices such as smart meters, wearables, asset trackers and industrial sensors.

SAE to develop guidelines for resilient GNSS receivers

The international standards organization SAE International is beginning a project to produce guidelines for resilient GNSS receivers.

According to Bill Woodward, chair of the organization's Positioning, Navigation, and Timing Committee, "The low power level of GNSS satellite signals at the Earth's surface makes receivers very susceptible to interference that effects their performance. There is a need for a standard that provides guidelines for resilient GNSS receivers which are less susceptible to interference."

Woodward's committee has already produced a number of important PNT-related documents. These include:

- S. National Grid Standard SAE1002
- Requirements for a Terrestrial Based Positioning, Navigation, and Timing (PNT) System to Improve Navigation Solutions and Ensure Critical Infrastructure Security SAE6857
- Transmitted Enhanced Loran (eLoran) Signal Standard SAE9990
- Transmitted Enhanced Loran (eLoran) Signal Standard for Tri-State Pulse Position Modulation SAE9990/1
- Transmitted Enhanced Loran (eLoran) Signal Standard for 9th Pulse Modulation SAE9990/2

www.sae.org

Skydel launches SDX 19.1 version of GNSS simulation

Skydel Solutions recently released SDX 19.1, the eighteenth major revision of its GNSS Simulator. This newest GNSS simulator version adds Galileo AltBOC support, atmospheric errors, SBAS improvements, and GNSS satellite antenna patterns.

SDX now supports Galileo AltBOC as a new GNSS signal type. Current SDX users licensed with the Galileo E5 signal will be able to generate 8 Phase Shift Keying (8-PSK) constant envelope AltBOC after upgrading to SDX 19.1. The signal can be generated by selecting both Galileo E5a and E5b in the output – signal selection panel.

OriginGPS multi-constellation module ready for IoT

OriginGPS, maker of small-format GNSS modules and cellular internet of things (IoT) systems, will be presenting new products with customized IoT and GPS.

OriginIoT systems enable developers to rapidly develop IoT products with stackable add-ons, while all data is configured from the cloud, and no additional embedded code or RF knowledge is required.

OriginGPS' latest release is the multi-constellation ORG1518-MK06 module. It combines low power modes for extended battery life, 8MB built-in Flash memory, AGPS support for extended ephemeris improving position calculation, and UART+I2C or UART+SPI interfaces. *https://origingps.com*

Insight platform delivers construction intelligence

Fugro's global launch of Gaia Insight introduces a new route to de-risking major construction works and shortening project cycles. The first of a suite of Gaia products, the online platform delivers geotechnical, geological and structural insights. It integrates site investigation, real-time geotechnical and structural monitoring IoT and third-party data, and provides the analytics required to lower ground risk and accelerate construction project schedules.

The web-based platform is aligned with Fugro's strategy of digital innovation. The platform is designed to overcome the challenge of understanding the Earth and visualising the subsurface in major construction works. Gaia Insight delivers verified data in real time, reducing uncertainties, lowering the risks of geotechnical failure and avoiding disruption to the adjacent environment.

The platform is already used at large infrastructure construction sites and in civil engineering assets, providing real-time data insight and risk visualisation. In more than a hundred projects to date, it is processing over 12-million measurements per day to facilitate decision support and provide an overview of data. Regional expansion of Gaia Insight is planned for 2019. *www.fugro.com*

TDK's new image stabilization software controller

TDK Corporation's group company, InvenSense, Inc., has announced the launch of the industry's first SMA OIS software controller specifically designed to leverage the Qualcomm® Sensor Execution Environment, and enable the adoption of premium optics in smartphone cameras for Android Flagship. The solution leverages TDK SMA actuators and TDK's latest 6-axis CORONA premium motion sensors to provide a software controller based on CML's innovative SMA image stabilization designs and control logic.*www.invensense.com*

Imagery into Insight with The OneAtlas Platform

Airbus Defence and Space has released new version of The OneAtlas Platform, its collaborative environment to easily access premium imagery, perform large-scale image processing, extract industry-specific insights and benefit from Airbus assets for solution development.

The OneAtlas Platform provides access to data within the Living Library as well as value-added layers, Basemap and WorldDEM. The Living Library contains multi-resolution and premium optical satellite data, updated on a daily basis and immediately available via streaming, download and API. Basemap is a curated global imagery layer, updated annually and created from 1.5m and 0.5m resolution imagery. WorldDEM dataset, for 3D analytics and rendering, is available in streaming format. The OneAtlas Platform also combines premium imagery and industry-leading expertise to deliver Thematic Services.

Bologna's First Tram Line use Road-Scanner4

Siteco Infomatica, in collaboration with the Engineering Department of the University of Messina, carried out the high-precision survey for the technical and economic feasibility planning of the first tramway in Bologna (IT). The realization of the project, born from a European tender issued last July, required technical verification of feasibility which the team successfully performed using the Road-Scanner4 mobile mapping system. The planned tramway route will develop for about 15 kilometres with two terminus stations.

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Commercial UAV Expo Europe
8-10 April
Amsterdam, the Netherlands
www.expouav.com/europe

Pacific PNT
8-11, April
Honolulu, HI USA
www.ion.org

European Navigation Conference 2019
9 - 12 April
Warsaw, Poland
http://enc2019.eu

FIG Working Week 2019
22 - 26 April
Hanoi, Vietnam
www.fig.net/fig2019

XIII International Navigation Forum & NAVITECH-2019
23 - 26 April
Moscow, Russia
http://glonass-forum.com

AUVSI Xponential 2019
29 April - 2 May
Chicago, United States
www.auvsi.org/events/xponential/auvsi-xponential-2019

May 2019

13th Annual Baska GNSS Conference,
5 - 8 May
Baska, Croatia

4th Joint International Symposium on Deformation Monitoring and Analysis
15 - 17 May
Athens, Greece
http://jisdm2019.survey.ntua.gr

Geo Business 2019
21 - 22 May
London, UK
www.GeoBusinessShow.com

5th International Conference on Geographical Information Systems Theory, Applications and Management
3-5 May 2019
Heraklion, Crete, Greece
www.gistam.org

June 2019

HxGN LIVE 2019
11 - 14 June
Las Vegas, USA
https://hxgnlive.com/2019

TransNav 2019
12 - 14 June
Gdynia, Poland
http://transnav.am.gdynia.pl

United Nations/Fiji Workshop on the applications of GNSS
24 - 28 June 2019
Suva, Fiji
www.unoosa.org

July 2019

Esri User Conference
8 - 12 July
San Diego, California
www.esri.com

August 2019

The South-East Asia Survey Congress(SEASC) 2019
15 - 19 August
Darwin, Australia
https://sssi.org.au

September 2019

GI4DM
3 - 6 September
Prague, Czech Republic
www.gi4dm2019.org

Intergeo 2019
17 - 19 September
Stuttgart, Germany
www.intergeo.de

ION GNSS+2019
16 - 20 September
Miami, Florida, USA
www.ion.org

MRSS19 - Munich Remote Sensing Symposium 2019
18 - 20 September
Munich, Germany
www.mrss.tum.de

PIA19 - Photogrammetric Image Analysis 2019
September 18-20, 2019
Munich, Germany
www.pia.tum.de

ISDE 11
24 - 27 September
Florence, Italy
digitalearth2019.eu

Interdrone
3-6 September 2019
Las Vegas, USA
www.interdrone.com

October 2019

The 8th FIG Land Administration Domain Model Workshop (LADM 2019)

4th International Conferenceon Smart Data and Smart Cities (SDSC2019)

Geomatics Geospatial Technology (GGT2019)
1 - 3 October
Kuala Lumpur, Malaysia,
http://isoladm.org
www.geoinfo.utm

Commercial UAV Expo Americas
28 - 30 October
Las Vegas, USA
www.expouav.com


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