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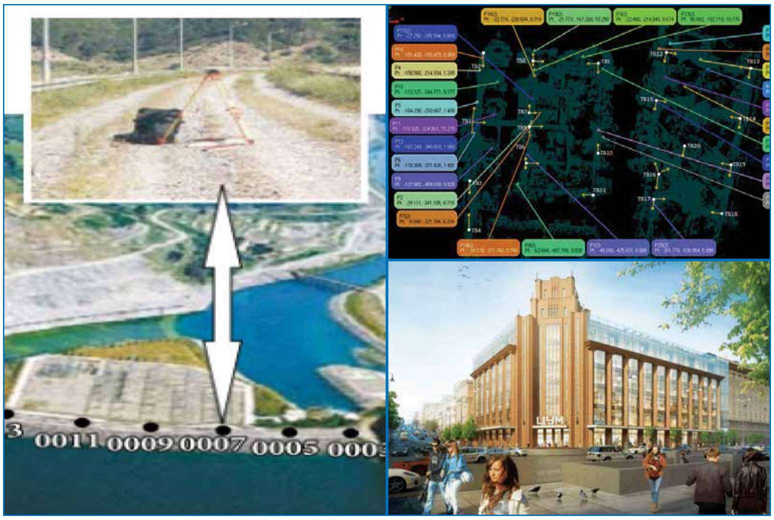
Vertical displacements of engineering structures

'SBAS test-bed has been fully operational in Australia since 2017'



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Columns

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

Email
[information] talktous@mycoordinates.org
[editorial] bal@mycoordinates.org
[advertising] sam@mycoordinates.org
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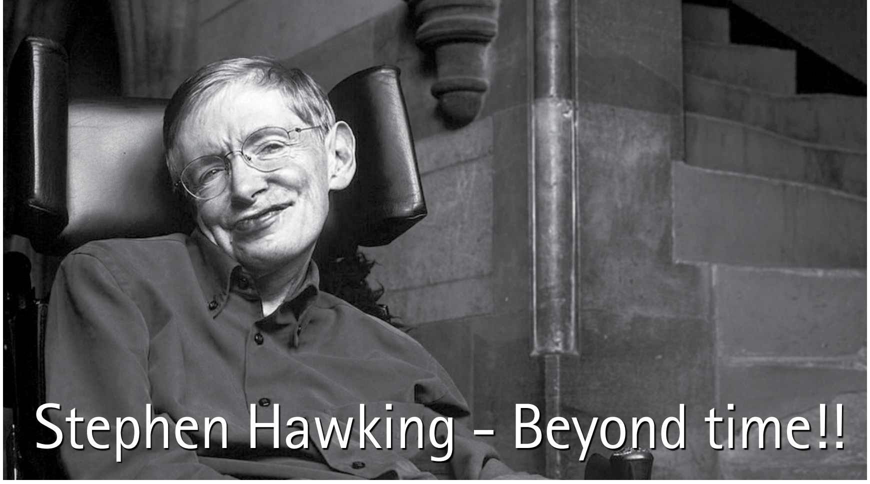

Stephen Hawking – Beyond time!!

You came

And enriched the world,

The world of science,

And the world of knowledge.

Moreover, you epitomized

The unimaginable abilities and tenacities

Of the human spirit

That could triumph

Any oddity of any magnitude.

You have gone

Beyond the frame of Space-Time,

You will remain as a beacon

In the world of cosmology,

In this cosmos, always.

Bal Krishna, Editor
bal@mycoordinates.org

"The surveying profession has a history of quick and agile adaptation to technology changes"

says Dr Chryssy A Potsiou, President International Federation of Surveyors (FIG) while discussing the mandate and achievements of FIG and issues before surveying community and profession

Tell us about FIG. What is its vision?

FIG was founded on July 18 1878 in Paris by delegates from seven national associations - Belgium, France, Germany, Great Britain, Italy, Spain and Switzerland. Today FIG has been recognized by the United Nations and the World Bank as the leading international non-governmental organization on geospatial information and the management of "land", the "sea" and the "built" environment. It is within the surveyors' task to determine the size and shape of the earth, to map its surface and to manage it in a sustainable way. FIG is the Federation of national member associations as well as affiliated members, academic members and corporate members from over 120 countries, and covers the whole range of professional fields within the global surveying community, such as professional and educational aspects, surveying, cadastre, property valuation and management of real estate, spatial information management, geodesy, photogrammetry, remote sensing, hydrography, planning and construction economics and management. It provides an international forum for discussion and development aiming to promote professional practice and standards.

The vision of FIG is of a modern and sustainable surveying profession in support of society, environment and economy by providing innovative, reliable and best practice solutions to our rapidly changing and complex world, acting with integrity and confidence about the usefulness of surveying, and translating these words into action.

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What is the mandate and the role of FIG?

The role of FIG is to support a prosperous and sustainable profession of surveyors to provide solution functionality, reliably and affordably for a complex and rapidly changing world that cannot wait. FIG supports international collaboration among its members, as well as its sister and regional organizations, for the progress of surveying in all its fields and applications everywhere. FIG also cooperates with the UN bodies, including FAO and the World Bank, in support of governments for the implementation of the ambitious Sustainable Development Agenda 2030.

It is the mandate of FIG to create "global" surveyors capable to contribute to the sustainable development agenda. Surveyors who will have a "global education" that covers all fields of surveying but also who will have an understanding of the "global challenges" and who will be capable to develop the profession and work efficiently everywhere in order to improve every part of our world, so that nobody will be left behind.

What are the areas where FIG is currently focusing?

One of the major efforts of FIG is to continuously develop the profession and at the same time to increase the value of the surveyors' services to society. We aim to increase the value of our geodata and of our land tools in order to deliver more economic and social benefit with greater transparency and environmental quality toward more fairness, more safety, more efficiency in governance of urban and rural areas, more smart and happy cities.

The greatest challenge of our profession today is to secure tenure and ensure and map property rights for all by 2030 and that way to contribute to the number 1 Sustainable Development Goal extreme poverty alleviation. Our mission is to contribute to this effort. Cadastral data on many millions of unregistered parcels referring to spatial units, rights (including use rights), persons and parties must be collected, linked, maintained and published timely in a reliable, affordable and inclusive way.

Surveyors all over the world are committed and encouraged to test and take advantage of the current and emerging technological developments such as all available 3d tools, BIM, GNSS, UAVs, digital cameras, smart devices, the cloud, blockchain technology, Internet of Things, and crowdsourcing methodology in order to improve their service to society.

Let us consider how the world was structured and how people used to live, think and work before electricity was invented. And how electricity has changed the way people live and work, and the way we construct our built environment. Similarly, the current and emerging technological developments are anticipated to change the way we live and work radically; they will inevitably change our profession as well. They will enable the digitalization of our society and will enhance globalization. Access to property rights on land for all: young and old, rich and poor, male and female, as well as property registration at the global level, a difficult technical and political issue for centuries, has become achievable in our days due to the technological developments. And we do believe that our generation will make this happen.

FIG has coordinated efforts of all 10 Commissions to provide the needed network and information sharing on professional issues and ethics, continuing professional development, spatial data infrastructures, marine issues and the Blue economy, technical aspects, fit for purpose land administration, 3d cadastre, cadastre 4.0, design and development implementation standards in the land administration domain, land use and planning issues, property markets, valuation and taxation, and quantity surveying.

Can you highlight some of the achievements of FIG?

We cooperate with UN bodies, including FAO and the World Bank in order to raise awareness of the value of geospatial information and land tools, and we maximize our efforts to outreach and strengthen capacity-building especially in developing countries, as well as to support harmonization in institutional arrangements in geospatial information management.

Our cooperation with international organizations includes contributions to the development of a global 5-year strategic plan for the implementation of the global geodetic reference frame; the development of geospatial standards, the International Construction Measurement Standards (ICMS) which was launched in July 2017; and provision of technical support to governments to establish national and regional spatial data infrastructures. The development of various guidelines and the sharing of principles in current trends in legal and policy frameworks is vital as we assist countries to take practical actions to achieve a digital transformation, and to bridge the geospatial digital divide in the implementation of the 2030 Agenda for Sustainable Development.

We have produced publications on property taxation, on fit-for-purpose land administration, on 3D cadaster and on formalizing informal settlements. We published the Social Tenure Domain Model in Arabic, French and Japanese. We work on more publications in the field of real estate markets, a guide for formalization of informal development, a publication on valuation of unregistered lands, as well as on block chain and on crowdsourcing in surveying. We continue to contribute in the Global Land Tool Network; we have contributed in the development of the International Ethics Standard and we have supported the adoption of the Global Surveyors' Day. These are some of our recent achievements.

Do you think that the surveying profession is transforming enough to keep with the pace of the technology changes?

The surveying profession has a history of quick and agile adaptation to technology changes since World War II, from the use of the measuring chain, steel tape and theodolite to GPS, precise point positioning, real time kinematic measurement, several generations of computer technology, GNSS, LIDAR, UAVs, smart devices and multiple other advances. The surveying profession in this 21st century is constantly adapting to new tools and new concepts. It now becomes obvious that we are currently both challenged and excited by the new

The greatest challenge of our profession today is to secure tenure and ensure and map property rights for all by 2030 and that way to contribute to the number 1 Sustainable Development Goal extreme poverty alleviation. Our mission is to contribute to this effort

concepts like The Internet of Things, the block chain (and crypto currencies), data mining, VGI and crowdsourcing. The profession will have no difficulty adapting to the marvelous advances yet to come. As for the expectations of the users of surveying services, the profession has likewise demonstrated its ability to meet the needs and demands of society by rigorous educational efforts and the innovative energy of its members.

How do you see the role of new technologies like UAVs?

Surveyors quickly adopted any practical uses for UAVs, and they use them as a tool for faster and cost-effective production of traditional surveying products such as orthophotos, and for the creation of innovative applications such as real-time monitoring of constructions, etc. There is such a large variety of UAVs available now as to their size, cost, and carrying ability of data collection sources (such as optical and thermal cameras, LIDAR) that may be used for a variety of surveying applications such as archaeological documentations, 3D models creation, DTM and DSM production, monitoring, disaster management, cadastral applications up to mine documentation and recording of minerals, indoor applications or other specialized uses that may develop without compromising the precision of surveying work, remembering that the UAV started out as a mere toy, and like many technological advances was an innovation looking for a useful role. It is a tool still under development that will give us more surprises in future.

What is your views on crowdsourcing?

Crowdsourcing, a relatively new concept in surveying today, is, like all new concepts, defined differently by different experts. "How the power of the many can be leveraged to accomplish feats that were once the responsibility of a specialized few." Another says that crowdsourcing is "The practice of obtaining needed services, ideas or content by soliciting contributions from a large group of people…". The principle of crowdsourcing is, apparently, that more heads are better than one, and that every person has something of value to contribute. How, then, is crowdsourcing an application of benefit to surveying? Much of what we read about crowd sourcing has to do with so-called ideation, meaning that the technique is applied in a search for new ideas, e.g., to support the Sustainable Development Goals (SDGs). It is used for problem solving. Crowdsourcing is often used in micro-tasking, that is, in breaking work up into very small tasks and sending the work out to the "crowd." The theory is that work may be done faster and cheaper and with fewer errors when validation systems are in place. We understand that when crowdsourcing is utilized in surveying, its value is primarily in the geo-data collection process. As an example, collecting data about certain species of trees or about the damaged constructions following a disaster in an urban environment, or even for first draft registration of property rights in areas lacking a land administration system in order to meet the SDGs by 2030, could be accomplished affordably, reliably and timely by the "crowd." When used in surveying the issue of validation will be critical, and assumes a certain amount of preparation and training of members of the so-called crowd. In which case, is it really a crowd or should it be thought of as a collection of amateur volunteers? But is crowdsourcing suitable for identification of fixed objects and material features, as is the objective of much surveying? The presentation of such information in x, y, z format is what surveyors do so that other professionals, like engineers and constructors, will incorporate the information into their own professional operations. For the professional surveyor in this type of crowdsourcing activity precision and accuracy are paramount and the risk of liability is problematic. This suggests that crowd sourcing in surveying will be concentrated on data-collection that is not positionally critical. Crowd sourcing has been likened to outsourcing, that is, sending jobs out of a company or institution to some other pool of cheaper labor with the euphemism of crowd funding. As such, it has been met by social resistance in some quarters. This seems unlikely in surveying as long as the data collection services that are outsourced are not within the scope of classical data collection as provided by professional surveyors. All of which suggests a general rule for the application of crowd sourcing in surveying: It may involve the collection of information that is required to be neither positionally precise nor dimensionally accurate, yet, important enough to achieve the SDGs; and as long as positioning and validation improve, the use of VGI information will be relevant. FIG is working on a relevant publication.

Please share your views on 3D cadastre?

Much of the current research by the surveying profession in this field focuses on issues related to 3d geo-information, tools for 3D data collection, cloud solutions, data management, optimizing processes and web-based information dissemination; standardization of 3d information, advanced modelling and visualization, as well as formalizing and building sustainable real estate markets as a pillar for robust economic urban

> The surveying profession in this 21st century is constantly adapting to new tools and new concepts. It now becomes obvious that we are currently both challenged and excited by the new concepts like The Internet of Things, the block chain, data mining, VGI and crowdsourcing

> Surveyors should be prepared to deal with data inflation, to cope with this large amount of information; they should also maintain in-depth research, and better education

growth; and related policies, legal and institutional aspects and knowledge sharing in operational experiences, the emerging challenges and good practices. The significance of these areas of interest for the good management of land, the sea and especially the built environment is well understood. No reality has a more direct bearing on the subject of 3 dimensional geo-information and cadaster than the growth of large cities, especially in the developing countries of the world, and especially in the phenomenon of the mega cities.

How do you see the future of Surveying education?

It becomes obvious that in the urbanization and globalization era, a globalization of science is also taking place. Surveyors should be prepared to cooperate with several other disciplines and allied professions; in some cases there may be severe competition from neighboring disciplines, as well; this is a challenge surveyors need to face through development of their own skills. Surveyors should be prepared to deal with data inflation, to cope with this large amount of information; they should also maintain in-depth research, and better education. Through cooperation with other professionals surveyors will increase their skills. And, yes! As an academic I do believe that students are fascinated by the broad range of tasks a modern surveyor may undertake and the increased value of our services for society and they do realize that as long as they keep improving their skills there is no fear of unemployment in our profession. Since the time of Euclid in Ancient Greece and of Pharaoh in Egypt there is so much to be done in the management of land, the sea and the built environment to support the development of smart cities and the geospatial transformation of society that our profession will always be of great value.

What are the challenges before the surveying profession?

The challenges for our profession are as they always have been: To remain relevant to social change and the changing demand for our services; to find the best and most practical use of technology; and to provide the best and most progressive educational preparation for young people looking to enter an exciting career of great promise.

Vertical displacements of engineering structures

A case study of classification and prediction models during buildings reconstruction

Roman Shults
Professor, Dr of Science.
Dean of the Faculty of GIS and territory management, Kyiv National University of Construction and Architecture, Ukraine

The paper presents the results of research of various classification models for vertical displacements and their further prediction. When performing geodetic monitoring of complex engineering structures under reconstruction, the displacements of the structure is always unequally. In this case, it is impossible to construct a single prediction kinematic model for the whole structure.

Therefore, it is necessary to classify the displacements and divide the structure into blocks, within which displacements occur equally. After obtaining blocks within which the process of displacement can be considered uniform, the different prediction kinematic models of displacements by the method of random functions were investigated.

The basis of the presented research were results of geodetic monitoring of the façade structures of the historic building in Kiev (see Fig. 1 and Fig. 2). This historical building was built in 1930 in the architectural style which is known as "socialist realism".

The reason of these vertical displacements was the process of reconstruction, which was started in 2013 and was carrying out in difficult geological conditions. This reconstruction project has two important features. The first, during the reconstruction of the building, all structures were disassembled except for the façade one, which was kept by special metal retaining structures during reconstruction works (see Fig. 2).

The second, with the height of the historical façade structure of 30 m, an underground parking of 20 m depth was built inside the building. The distance between the historical part of the façade that was kept by metal structures and the edge of the underground parking pit was only 5-6 m. Under such conditions, the vertical displacements in some places exceeded the allowable displacements by ten times and reached 110-120 mm for two years.

The results of geodetic monitoring in form of deformation surface are presented in Fig.3.

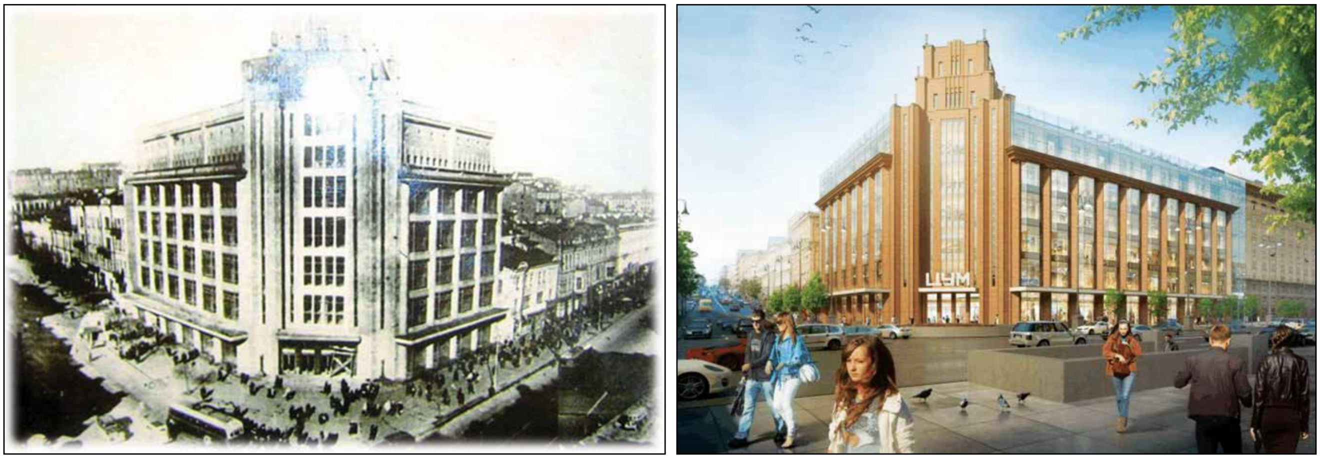

Figure 1. Exterior view of the original façade in 1939: (left) and after reconstruction in 2016 (right)

From Fig. 3 is clear that deformation process is not uniform. In Fig. 4 deformation marks that were installed around the building façade are presented.

Prediction by using random functions

At the study and prediction of structure vertical displacements, we should consider two tasks:

- determination of the nature and distribution of vertical displacements within the structure;
- construction of adequate prediction model.

The first task is logically connected with the second.

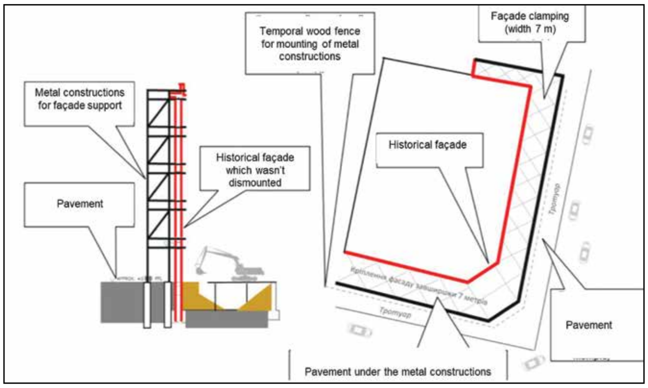

Figure 2. Vertical and horizontal view of building façade and retaining structures

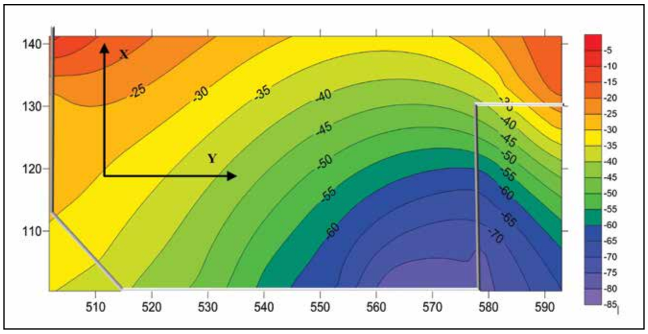

Figure 3. Vertical displacements at the end of the first year monitoring

Determination of the nature and distribution of vertical displacements within the structure makes it possible to allocate the deformation blocks within which the deformation process is described by the same laws (equations). Thanks to this, it becomes possible within the block with statistically identical displacements do not build a prediction model for each individual deformation mark and to use the entire volume of measurements to construct a prediction model that will describe the deformation process for any point within the block.

Deformation blocks determination

Let's consider the first task of displacements modeling. Determination of the nature of change in displacements within the structure is a very difficult task. As a rule, the separation of the structure into blocks with statistically identical displacements is not obvious. The situation is further complicated by the presence of gaps in observations, or change the time of observation cycles that happens almost during monitoring process.

In work (Gulyaev, Yu.P. et al., 2013), authors presented their algorithm for allocation of homogeneous deformation blocks. As a criterion for the formation of statistically homogeneous blocks, the authors use the coefficient of variation $V_{\Delta S}$. At the first step the vertical displacements are placed in decreasing order. It is assumed that the mean values within the blocks are significantly different from the overall mean value, root mean square error within the block is minimal and approximately within the blocks. The vertical displacements group is considered homogeneous if $0{,}25 \le V_{\Delta S} \le 0{,}33$.

From our calculations the coefficient of variation equal 0.32 and therefore, the deformation process of whole façade is homogeneous. However, from Fig. 3 we can conclude opposite. Thus, despite the statistical validity, the proposed criterion for calculating the number of homogeneous deformation blocks does not always ensure adequate acceptable results. In addition, in this method there is some arbitrariness in choosing the coefficient of variation, which significantly reduces the accuracy of the approach.

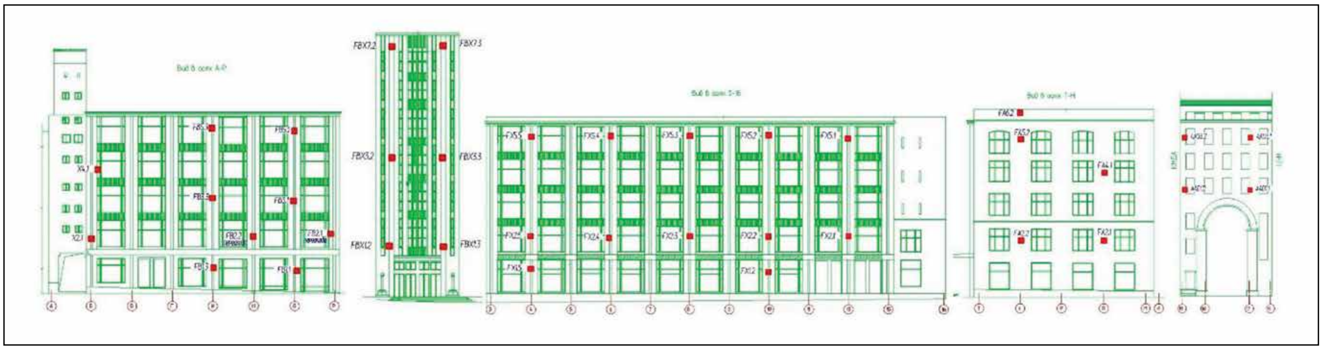

Figure 4. Position of deformation marks around the building façade

We proposed to use an alternative method for calculating the number of deformation blocks. This method is based on the use of cluster analysis of vertical displacements.

For the analysis, horizontal coordinates of the deformation marks and characteristics of soils at their locations were used. The following methods were investigated: sum of distances, maximum distance and sum of squares of distances. In Fig. 5 presents the results of a cluster analysis of vertical displacements by the method of sum of squares of distances.

All the results of the cluster analysis, in contrast to the method of the coefficient of variation, showed the same distribution of all deformation marks on three blocks (Fig 6).

Within each block, the average value of the displacement is: red block - 75.4 mm; blue block - 44.0 mm; yellow block - 21.0 mm. Within each of these blocks, vertical displacements can be considered homogeneous.

For control of the results of cluster analysis we used Group Method of Data Handling (GMDH). In Fig. 7 presents the results of GMDH analysis of vertical displacements which correspond to the results of the cluster analysis.

A necessary condition for the application of the theory of random functions is the normal distribution of the measured displacements in each block. Verification of displacements by the normal distribution was performed using the skewness and kurtosis criteria. Totally 113 cycles of observations were analyzed. By the results of this verification was determined that from 20th cycle all displacements have a normal distribution. We used for future prediction models construction 93 cycles. Below, we will present and study the prediction models for the first block (displacements in the range from - 82 mm to - 50 mm).

Prediction model construction

The whole process of prediction model construction can be divided in four steps.

Description of prediction model

The prediction kinematic model of the deformation process is constructed in the form of the following two functions (Gulyaev, Yu.P. et al., 2012):

$$\hat{m}_X(t_2/t_1) = \hat{m}_X(t_2) + \hat{r}_X(t_2,t_1)\frac{\hat{\sigma}_X(t_2)}{\sigma_X(t_1)} x_i(t_1);\ \hat{\sigma}_X(t_2/t_1) = \hat{\sigma}_X(t_2)\sqrt{1-\hat{r}^2(t_2,t_1)};\quad (1)$$

where t_1 - the moment of the last observation cycle; t_2 - the moment on which the prediction of vertical displacement is performed; ^ - is a symbol of numerical parameters are obtained by means of prediction; $\hat{m}_{X_i}(t_2/t_1)$ - prediction of vertical displacement of deformation mark i at the moment t_2 under condition that we know: $x_i(t_1)$, $\hat{m}_{X_i}(t_2)$, $\hat{r}_X(t_2,t_1)$, $\hat{\sigma}_X(t_2)$ - centered value of vertical displacement of deformation mark i at the moment t_2 and estimates of mathematical expectation, autocorrelation function and root mean square error which are predicted at the time t_2; $\hat{\sigma}_X(t_2/t_1)$ - root mean square error that describes the expected error of prediction.

The construction of prediction kinematic model is reduced to the determination of statistical parameters of the

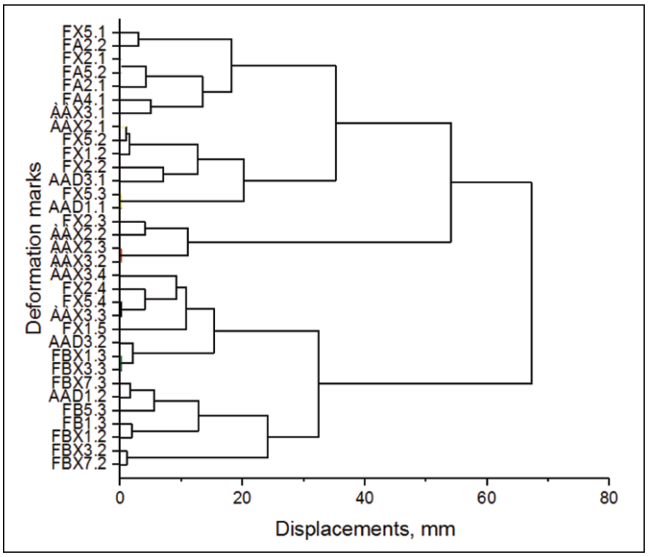

Figure 5 Dendrogram of cluster analysis by the method of sum of squares of distances

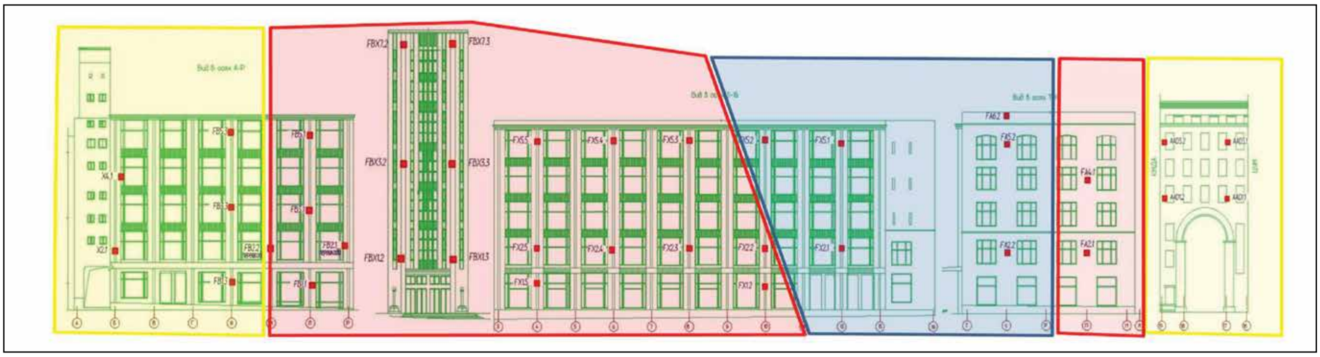

Figure 6 Façade with blocks of uniform displacements

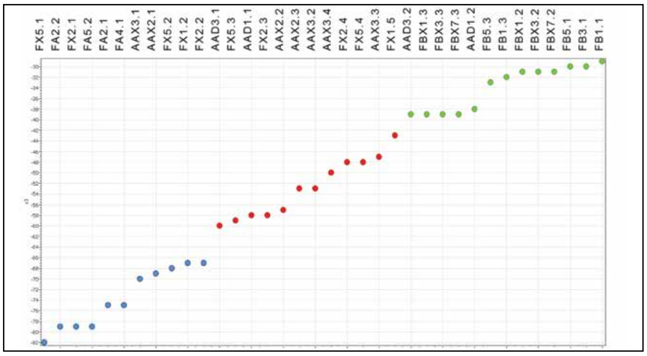

Figure 7. Separation of deformation marks on three blocks by GMDH analysis

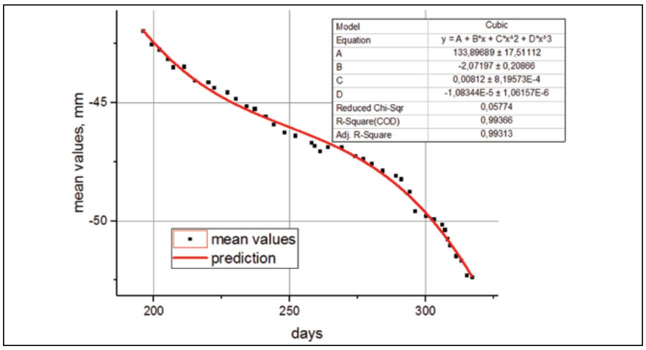

Figure 8. Trend approximation by polynomial (cubic) model

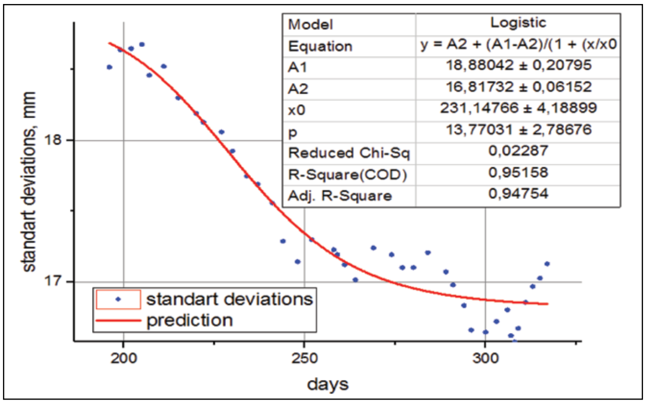

Figure 9. RMS approximation by logistic model

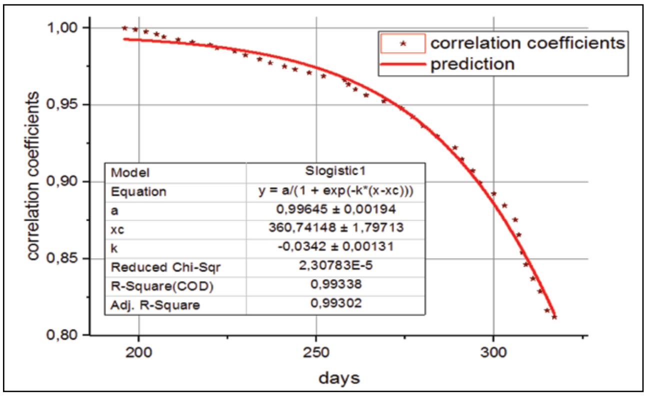

Figure 10. Autocorrelation function approximation by S-logistic model

distribution law of the process in each observation period and the subsequent approximation of these parameters in time. Stages of numerical estimates approximation of parameters $\hat{m}_{X_i}(t_2)$, $\hat{r}_X(t_2,t_1)$, $\hat{\sigma}_X(t_2)$ discussed below.

Trend approximation $\hat{m}_{X_i}(t_2)$.

Using the results of measurements for the last 93 cycles, different models of trend prediction were investigated. The following types of models of different degrees were studied: polynomial (Kovačič, B. et al., 2009), power, exponential, piecewise linear, rational and logistic. Despite of the fact that many authors suggest using linear model, this type of model gave unsatisfactory results. For selection of the best model, the correlation coefficient, the accuracy of determining the model parameters, and the sum of the squares of the deviations were used. As a result, it was obtained that the best characteristics have piecewise linear model of three segments (PWL 3) and the third-degree (cubic) polynomial model (see Fig. 8). These models were used for further research.

Root mean square error approximation (RMS) $\hat{\sigma}_X(t_2)$

The search of the model parameters for root mean square error approximation was performed by the scheme similar to the search of trend parameters. As a result, it was obtained that the best characteristics have the PWL 3 model and the logistic model (see Fig. 9). These models were used for further research.

Computation and approximation of autocorrelation function $\hat{r}_X(t_2,t_1)$

The calculation of the autocorrelation function parameters of the deformation process is performed on the centered values of vertical displacements: $x_i(t_j) - m_X(t_j) = \overset{\circ}{x}_i(t_j)$.

The correlation moments between the current measurements cycles of random process are calculated as:

$$K_x(t_{jk}, t_{jl}) = \frac{1}{n-1}\sum_{i=1}^{n}\left[x_i(t_k)x_i(t_l)\right] \quad (2)$$

where k, l - numbers of current measurements cycles; i - number of deformation mark.

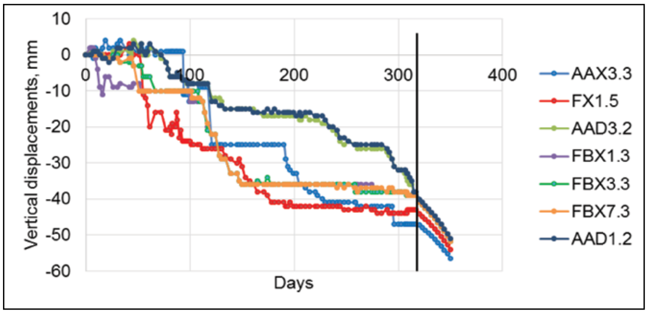

Figure 11. Measured vertical displacements and prediction by the model 2 (after black line)

Then, we turn to the normalized values:

$$r_x\left(t_{jk},t_{jl}\right)=\frac{K_x\left(t_{jk},t_{jl}\right)}{\sigma_x\left(t_{jk}\right)\sigma_x\left(t_{jl}\right)} \quad (3)$$

From the normalized autocorrelation matrix, calculate the correlation coefficients. For approximation of autocorrelation function, we used the same models as previously. As a result, it was obtained that the best characteristics have the third-degree (cubic) polynomial model and S-logistic model (see Fig. 10). These models were used for prediction models study.

Study of prediction models

According to our previous research were formed twelve different prediction models (see Tab. 1). All of these models were investigated using equations (1).

In order to define better model we made a prediction on ten cycles backward and compared prediction results with real displacements. By the deviations between predicted and measured values the root mean square error for each model was calculated. In such a way we got the better model, which has a minimum root mean square error and which consists from the next equations (see model 2 in Tab. 1):

Table 1. Prediction models

Model N	Trend function	RMS function	Autocorrelation function	Model N	Trend function	RMS function	Autocorrelation function
model 1	cubic	logistic	cubic	model 7	PWL3	logistic	cubic
model 2	cubic	logistic	Slogistic	model 8	PWL3	logistic	Slogistic
model 3	cubic	logistic	PWL3	model 9	PWL3	logistic	PWL3
model 4	cubic	PWL3	cubic	model 10	PWL3	PWL3	cubic
model 5	cubic	PWL3	Slogistic	model 11	PWL3	PWL3	Slogistic
model 6	cubic	PWL3	PWL3	model 12	PWL3	PWL3	PWL3

$$\hat{m}_X\left(t_j\right)=133.87-2.07t_j+0.0081t_j^2-0.000011t_j^3\,;$$

$$\hat{\sigma}_X\left(t_j\right)=16.82+\frac{2.06}{\left(1+\left(\frac{t_j}{231.15}\right)^{13.77}\right)},$$

$$\hat{r}_x\left(t_2,t_1\right)=\frac{0.996}{\left(1+e^{0.034(t_2-360.74)}\right)}$$

The possibilities of the theory of random functions in the prediction of deformation processes have not been fully investigated yet

These equations were used for the following forward prediction on ten cycles. One of the example of this prediction is presented in Fig.11.

Conclusion

Summarizing the studies made, we can confidently state that the possibilities of the theory of random functions in the prediction of deformation processes have not been fully investigated yet. The results above is showing that an obligatory condition for using the theory of random functions is the obtaining of homogeneous deformation blocks. In solving this problem is well-established cluster analysis method. However, to solve this problem, ANOVA method can also be used which needs further investigation.

As a result of the study of various prediction models, optimal prediction models for the trend, root mean square error and autocorrelation function were obtained. The results of this study confirm that for complex deformation processes, simple linear and exponential models are ineffective. Further, to improve the quality of prediction models, it is recommended to conduct in-depth statistical analysis of measured vertical displacements in order to avoid blunders and systematic errors.

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"The SBAS test-bed has been fully operational since Oct 2017"

says Dr John Dawson, the Section Leader of Positioning at Geoscience Australia in an interaction with Coordinates

What is the need and objective of Satellite based augmentation system test bed project of Australia?

Despite the technology being employed in countries around the world, including the United States, Europe, China, Russia, India and Japan, a SBAS has not been previously used or tested in Australia or New Zealand. Our SBAS test-bed is assessing the application of SBAS technology and its safety, productivity, efficiency and innovation benefits to Australian and New Zealand industry.

Testing will continue until 31 January 2019 and will evaluate the effectiveness and application of SBAS in ten main sectors: agriculture, aviation, construction, maritime, mining, rail, road, spatial, utilities and consumer. The test-bed will address the specific requirements (including accuracy, integrity, availability) in applications areas in each of these industry sectors.

Is the project operational?

First test signals were transmitted in June 2017.

From October 2017, the SBAS test-bed has been fully operational. Second generation SBAS and Precise Point Positioning have been confirmed to provide positioning accuracies of several decimetres and ten centimetres respectively across Australia and New Zealand. The test-bed is also the first in the world to trial Precise Point Positioning corrections integrated into a SBAS service.

What is the frequency and coverage area?

The L1 SBAS and L5 SBAS service regions are plotted in the attached maps. The SBAS test-bed is transmitting on GPS L1 C/A signal centred at 1575.42 MHz and L5 signal centred at 1176.45 MHz.

Which application segments are likely to be benefited by SBAS Australia?

The transport, mining and agricultural sectors in Australia are likely to be particularly benefited by SBAS. Each has a strong need for improved satellite positioning capabilities. As part of the test-bed an economic benefits analysis is currently being undertaken, with initial results anticipated to become available later this calendar year.

What is your plan for aviation sector?

The test-bed is supporting two aviation projects. One in Australia, coordinated by Airservices Australia, and another in New Zealand, coordinated by Airways NZ.

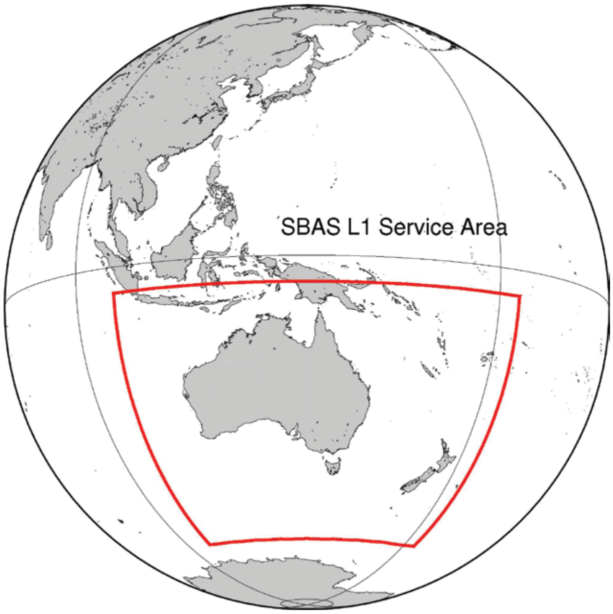
We know that a SBAS would make air travel safer, reduce minimum fuel carriage, and increase payloads and operational efficiencies.

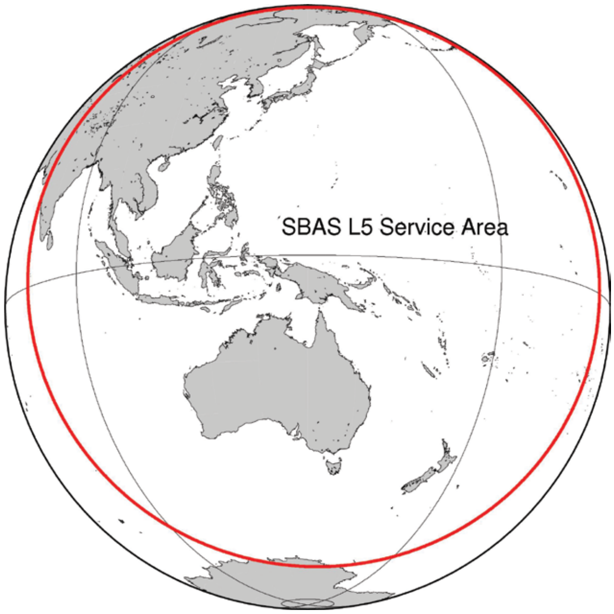
Regional aviation is particularly important in Australia and SBAS technology would support aircraft approaches during adverse weather at remote emergency landing strips, airstrips and hospital helipads.

Subject to future funding, it is foreseen that Australia would seek to develop an International Civil Aviation Organisation (ICAO) Compliant SBAS to support Australian aviation.

What satellite PRN you plan to use for this project?

Regional aviation is particularly important in Australia and SBAS technology would support aircraft approaches during adverse weather at remote emergency landing strips, airstrips and hospital helipads.





The GPS Directorate within the US Air Force, has allocated satellite PRN 122 for our test-bed. We've been authorized to utilise this PRN for the period of 1 May 2017 through 31 January 2019. We're utilising the Inmarsat 4F1 satellite which is located in a geosynchronous orbit at 143.5 degrees longitude to transmit our SBAS signals.

What are your future plans?

This is subject to a future decision by the Australian Government. We have however been delighted in the enthusiasm and interest this project has generated across Australian industry. We're also sure that satellite positioning capabilities will be an important part of Australia economy into the future.

As more and more countries plan to have their own GNSS systems, what advantages and implications do you see for such a scenario?

We've been watching with interest the progress being made by the United States, Europe, China, Russia, India and Japan in deploying their own GNSS. Australia fortuitously is located in the so-called 'GNSS hotspot' with good visibility of all these GNSS. We see this as a clear opportunity and our national positioning infrastructure plan puts emphasis on Australia being able to use all the GNSS. This means we're not dependent on any one system. We're also confident that the performance (accuracy and robustness) of multi-GNSS positioning will be better than the performance of any single system.

Because of the importance of satellite positioning to Australia's economy together with foreign government investment in GNSS elsewhere, we see a clear need for the Australian Government to now become actively involved in ensuring our industry has access to capabilities that match or better what is available elsewhere.

> We are confident that the performance (accuracy and robustness) of multi-GNSS positioning will be better than the performance of any single system.

With increasing dependence on GNSS, how do you the perceive the threats like interference, jamming and spoofing?

We're very aware of society's increasing dependence on GNSS, and we're aware that there is considerable work being undertaken across all the Australian governments as well as industry to better understand this dependence - in our experience it's not always immediately obvious. We do know for example that the energy, finance and communications sectors each utilise GNSS in their infrastructures in some way. We think this dependence analysis needs to be undertaken before a national strategy for the mitigation of interference, jamming and spoofing can be developed. Our efforts are a work in progress.

Given this, what¹s your opinion on GNSS back ups?

The Australian Government's Positioning, Navigation and Timing Working Group (PNT-WG) has representatives from each of Australia's federal agencies with an interest in PNT. The PNT-WG is watching with attention the development of all PNT technology but do not have plans to deploy any alternative to GNSS infrastructure at this time.

Auscultation by GPS of rockfill dam

The paper aims to analyze the behavior of rockfill dams using the ANSYS computer code; an application was made on Altinkaya Dam in Turkey

BOUHOUCHE Nadia
Centre of Space Techniques, Department of Geodesy, Oran, Algeria

GOURINE Bachir
Centre of Space Techniques, Department of Geodesy, Oran, Algeria

Dams are one of the most important engineering structures used for water supply, flood protection and agricultural activities. Besides, it is the most natural and cheapest way of energy production for a country. Dams constructed with high cost expenditures are subjected to deformation due to various loading factors such as water level, air, water temperature and rock deformability. Controlling these dams has become compulsory in order to prevent disasters [2].

There are generally two methods used to carry out the deformation surveys, namely geodetic and geotechnic.

Geodetic methods use total station, precise leveling instruments and geotechnic rely on instrumentations such as inclinometer and extensometer, which can effectively monitor one or two- dimensional modes of motion to sub-millimeter level.

On the other hand, the space-based geodetic method for instance, the Global Positioning System (GPS) offers a reliable and efficient method for three-dimensional survey [3].

This technology has been used for various surveying and mapping activities, including cadastral, engineering, hydrographic survey applications. Its ease of use and capability of very high accuracy make GPS an applicable system in dam stability monitoring of dams.

The objective assigned to this paper is to establish an analysis of geometric deformation of the Altınkaya dam in Turkey whose sealing is ensured by a central clay core.

Safety of Rockfill Dams

The most common causes of failure of the embankment dams are internal erosion of finegrained soils from the embankments, erosion under the foundation or abutment, stability problems resulting from the high pore pressures, hydraulic gradients, and overtopping of the dam or spillway.

Deformations of rockfill dam start occurring during the construction of the dam. These deformations are caused by the increase of effective stresses during the construction by the consecutive layers of earth material and also by effects of creep of material. Deformations are also influenced by the deformations of the foundation, the transfer of stresses between the various zones of the dam and the other factors [4].

Role of Monitoring

Deformation monitoring is generally a working procedure to ensure the safety of engineering structures and also to validate the engineering structures' designs [3].

All engineering structures are subject to deform and displace due to several factors such as environmental stress, structural overload, tectonic movements etc. Two methods used to carry out the deformation surveys, namely geotechnic and geodetic.

- **Geotechnical Surveillance**: rely on instrumentations such as inclinometer and extensometer, which can effectively monitor one or two- dimensional modes of motion to sub-millimeter level. However, spatial distribution of geotechnical instrumentation is usually limited to the locations that the instruments can be installed during dam construction.

- **Geodetic surveillance** or structural monitoring: use terrestrial instruments as precise leveling instruments, total stations, etc. It has become very important as more and more new engineering structures had been erected over the years. Comparatively, it is a slow process to GPS method.

Geometric survey of a rockfill dam by GPS

Since its inception in the early 1970s, GPS has become a widely used surveying tool. Today, accuracies at the centimeter level or better are routinely achieved using a variety of relative positioning techniques. These techniques range from near-instantaneous positioning over relatively short reference receiver to unknown receiver distances, to solutions requiring many hours of data and advanced modelling for distances between receivers of up to several thousand kilometers. Removal of the line-of-sight dependency for survey observation has radically altered the practices of the survey community, allowing larger areas and more points to be measured [5].

Monitoring using GPS, observation is done in triangulation style. Two or more GPS receiver are seated on the control points while some other GPS receiver will be place on the monitoring stations. In most situations, due to the limited numbers of available GPS receivers, the whole monitoring campaign is to be carry out in separate session. There must be at least one common station between two sessions.

Figure 1 shows the sample of a dam control network. The stability of the control network can be determined using conventional triangulation observation method (total station) or GPS observation (static observation). The blue triangles represent the stable reference points scattered around the dam. The red dots represent the monitoring (object) points situated on the dam surface.

After the observation, the raw data have to go through data processing in order to obtain the desired results.

With geodetic techniques it is possible to measure the displacement of pillars with respect to a reference network made up of stations that are supposed fixed (stable). This technique has the advantage of determining absolute displacements. To achieve this goal, we must follow these steps [6]:

1) Establishment of the reference network or guard network: Choose points out of the deformation zone (geologically stable points) and materialize them by concrete terminals. The altitude of the reference stations should be close to that of the study area. This network, which is supposed to be stable, serves as a backbone for all subsequent work carried out as part of the study.
2) Implementation of the Auscultation Network: Choose points that are well distributed and delimit the area of influence of the reservoir (upstream and downstream sides and banks of the reservoir) and which are materialized by concrete terminals or sealed markers (stainless steel) in concrete sites. They will be used to study the behavior of the vicinity of the dam and as points of support for the target network.
3) Target network implementation: Choose homogeneously distributed targets, according to the form and type of dam, by an appropriate mesh. The targets (concrete markers and sealed markers in the concrete sites) must be materialized on the structure (the axis of the ridge, downstream / upstream facing, some ancillary works) and on its immediate vicinity (downstream foot of the book), in a sustainable way. This network will be used to monitor the behavior of the dam.

Application

Definition of Work Area

Altınkaya dam is 35 km south west of the Bafra, Samsun. This dam is structured by one of the Turkish Government establishments that is called State Hydraulic Works.

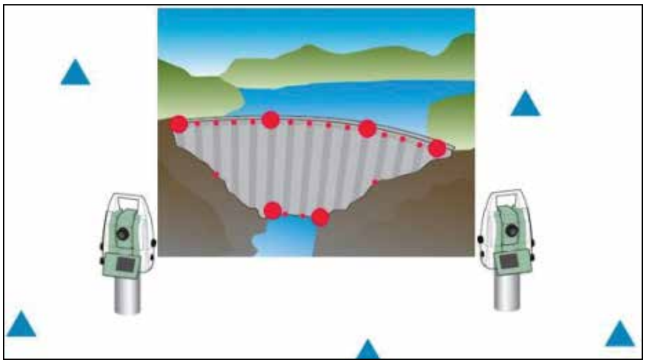


Fig.1. Monitoring network

Fig.2. Altınkaya Dam

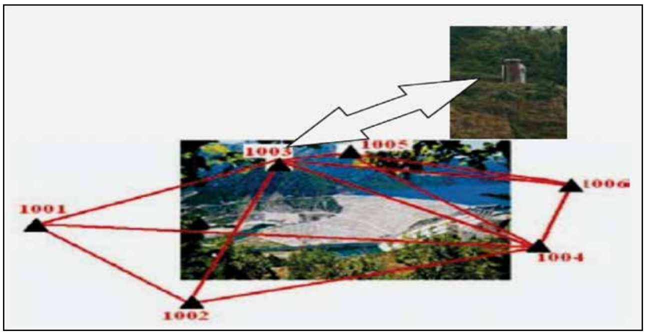


Fig.3. Reference network of Altinkaya dam [7]

Altinkaya Dam is 22nd among rock fill large dams in Turkey and also it is 32nd dams in the world. The dam is built on the Kizlirmak River as rock fill with clay having seeds. Height of the dam (from river bed) is 195.0 m. and crest length is 634.0 m. Reservoir area at normal water surface elevation is 118.31 km^2. Volume of the dam is 16 x 106 m^3. The dam is convex towards the water [7].

Building of monuments of reference and object points

Monitoring network consists of six reference stations (1001, 1002, 1003, 1004, 1005 and 1006); they were built as pillars on the stable ground which surrounds the dam.

In order to monitor and measure possible displacements at the crest, 10 object points were established at the crest when the dam was built (Figure 2). Since that time only one object point, numbered 0023, was added to the deformation network.

Fig.4. Object network of Altinkaya dam [7]

Table 1. Information related to the deformation network

Period N°	Measurement Date		Water level (m)
	Beginning	End	
1	21.09.2000	23.09.2000	170.34
2	05.06.2001	08.06.2001	167.53
3	20.09.2001	22.09.2001	164.20
4	27.05.2002	29.05.2002	177.23

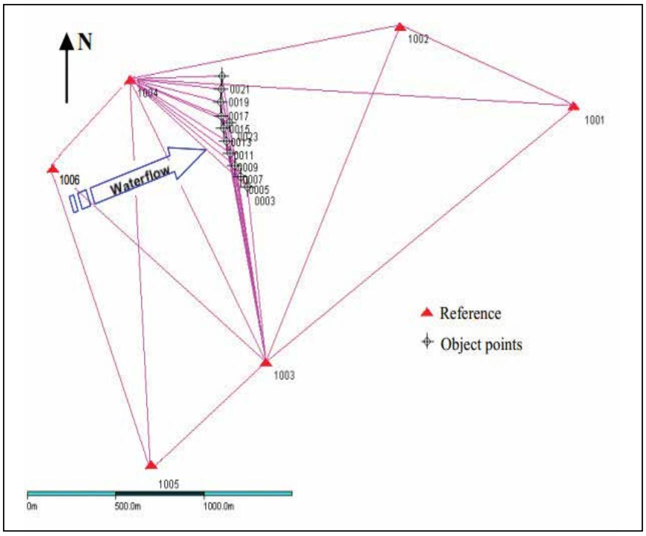


Fig.5. Altınkaya Dam deformation network [8]

This point was built because of the physical changes that had been observed in the surrounding area. The deformation measurements related to the reference and object network were made with 3 Ashtech Z surveyor GPS receivers and 700700B_Mar.III_L1/L2 GPS antennas [8].

Deformation measurements of Altinkaya dam

The deformation measurements of the dam involved four measurement campaigns and two separate measurements were made at the Altinkaya dam: one between reference points and the other within the object points.

For the measurement plan on the reference network, the observation period was selected 45 minutes with a sampling rate of 10 seconds. The satellite elevation mask was selected at 15°in order to avoid multi-path effect and cycle slip error.

Before commencing deformation measurements, all the equipment was calibrated. In order to avoid or diminish any equipment errors, the same GPS receivers and antennas were used at the same points in all periods [8].

The measurements were processed with GeoGenius 2000 software. The deformation network showed a maximum value of 0, 9 mm horizontally and 1, 7 mm vertically for the 4 observational periods. The adjusted coordinates and their covariances were obtained from a free network adjustment. The accuracy of the measurements of the horizantal deformations and the vertical displacements.

On remarque que le barrage ainsi que la zone environnante ont subi des déplacements horizontaux et verticaux, durant les différentes périodes d'observations.

Analysis of the movements of the GPS monitoring network

The differences of the local coordinates (E, N, U) of the surveillance network points, between the different periods, are illustrated as vectors form of horizontal and vertical displacements, according to the figures (6 and 7) we notes that the dam and the surrounding area have undergone horizontal and vertical displacements during the different observation periods.

Indeed, the average modulus of horizontal displacements at the reference points is of the order of 10 mm, 7 mm and 8 mm, according to the periods 1 & 2, 2 & 3 and 3 & 4, respectively. For the target points of the dam crest, the amplitude of these displacements is of the order of 2 to 10 mm.

Vertical displacements were observed at reference points:

- With an uprising of the order of 33 mm, between periods 1 & 2;
- With a subsidence of the order of 19 mm, between periods 2 & 3;
- With a subsidence of about 20 mm, between periods 3 & 4.
- For the target points, these movements are of the order of a few millimeters to a few centimeters.

According to a study conducted by [8] which consisted in the analysis of horizontal deformation of the GPS dam monitoring network, by the determination of unstable points, the results obtained are as follows:

- The points 0003, 0007, 0017, 0011, 0013 and 0019 on the crest dam and also the points 1002 and 1006 of the reference network; are unstable between 1st and 2nd periods. During these periods, the reservoir level decreased from 170.34 m to 167.53 m.
- The points 1001, 0015 and 0017 showed significant movements between the 1st and 3rd periods, during which the water level decreased from 170.34 m to 164.20 m.
- The points 0003, 0007, 0009, 0011, 0013, 0015 and 0019 showed significant movements between the 1st and 4th periods.
- The most of the crest dam points during these periods moved and the level of the reservoir increased from 170.34 m to 177.23 m.
- The direction of these displacements, according to the figure 8(a) is characterized, generally, by an upstream – downstream direction. However, the middle of the dam crest (targets 0007, 0009, 0011, and 0015) has undergone an upstream movement between the 2nd and 3rd periods figure 8 (b).

All these results lead us to the following conclusions:

- The horizontal movement of the dam crest was mainly affected by the hydrostatic charge of the reservoir at different water levels.
- The most significant movements were recorded at target points 0003, 0007, 0013 and 0019, in the middle and surrounding areas of the dam crest.
- Reference points such as 1001, 1002 and 1006 were considered unstable. Since most of the reference points are on the upstream side of the dam, it is probable that this area is affected by the hydrostatic charge at different water levels.

According to Figure 9, the vertical movement of the crest dam was characterized by a settlement of the medium (the targets 0009, 0011, 0013 and 0015) and a uprising of their surroundings (the targets 003, 005, 0007, 0017, 0019, 0021) of the order of 3 to 16 mm, during the period 1 & 2 (Fig. 8a).

On the other hand, during periods 2 & 3 (Fig. 9b) and 3 & 4 (Fig. 9c), the targets of the dam crest underwent a settling phenomenon of the order of 10 to 40 mm and 3 to 12 mm. , respectively.

Generally, this settlement phenomenon is the consequence of the effect of the self weight of the dam conjugated with the hydrostatic charge.

Conclusion

This analysis has verified the stability of the Altinkaya Dam using GPS survey measurements over a period of 2 years at four epochs (September 2000 to May 2002).

It showed that the crest of the dam has undergone horizontal and vertical movements characterized by a dominant direction towards the downstream and by a settling phenomenon.

The filling of the reservoir dam is modeled by the application of a hydraulic pressure on the upstream facing. The Altınkaya Dam showed maximum deformation at its crest due to its own weight and hydrostatic charge; its act is very important on the evolution of deformations and displacements.

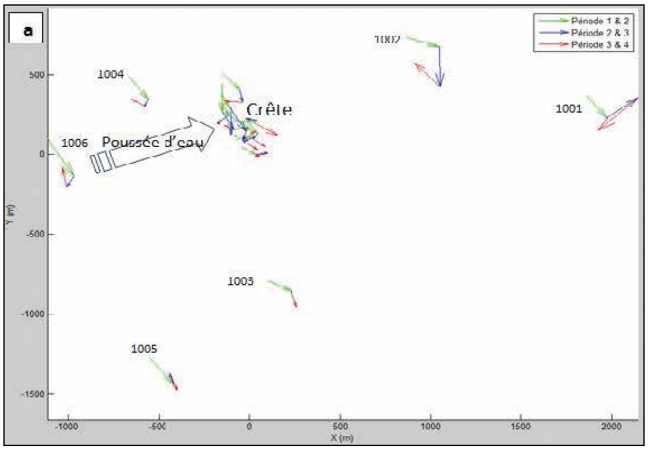


Figure 6. Vectors of horizontal displacements of the Altınkaya dam monitoring network, according to the different observation periods

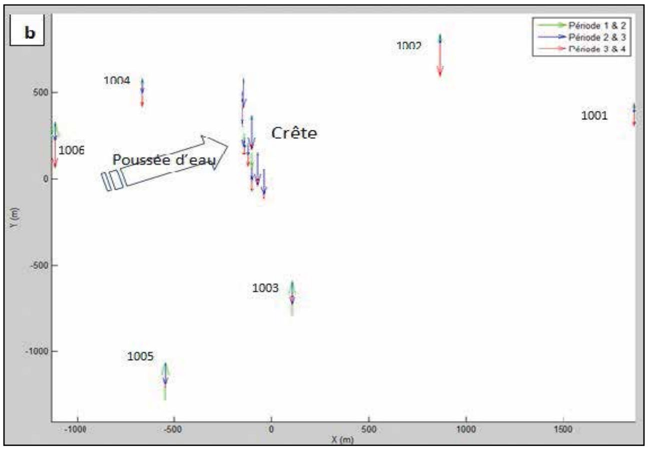


Figure 7. Vectors of vertical displacements of the Altınkaya dam monitoring network, according to the different observation periods

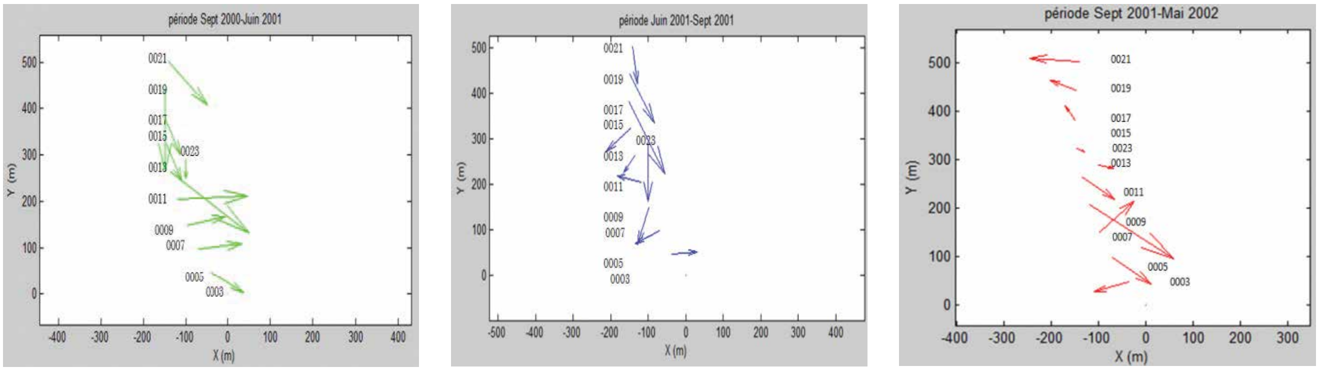


Figure 8. Vectors of the horizontal displacements of the target points of the crest of the dam, according to the different periods of observations

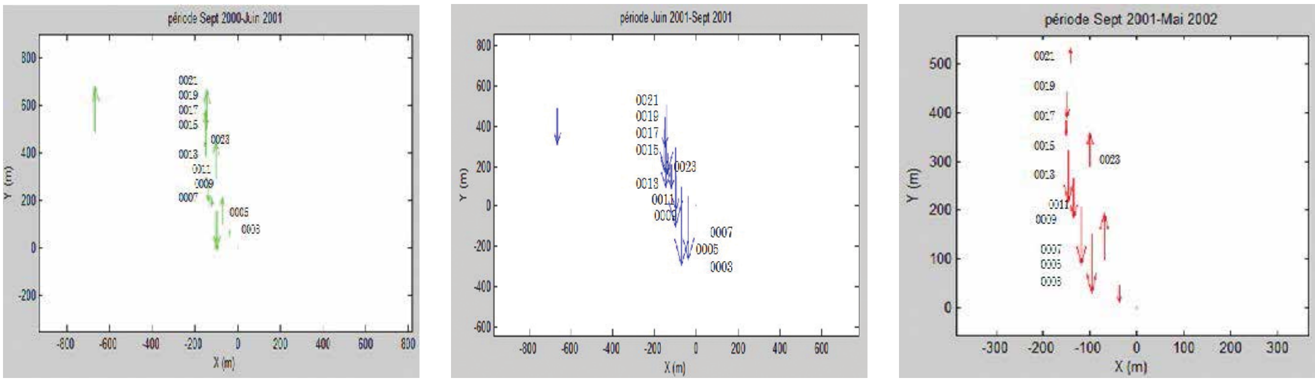


Figure 9.Vectors of the vertical displacements of the target points of the crest of the dam, according to the different periods of observations

The whole solid rockfill dam has a high compactness. It was found a general low settlement of the structure due to the actions of the self weight and the pressure of the water.

The whole solid rockfill dam has a high compactness. It was found a general low settlement of the structure due to the actions of the self weight and the pressure of the water. Based on the results of the analysis carried out, the structure can be considered to be quite satisfactory during the GPS observation period (09/2000 to 05/2002); the dam has all the guarantees of good durability.

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GNSS Spoofers, don’t mess with me!
Our Technology is our Defense.
Surveying with TRIUMPH-LS inside >>>

Front

Spoofer Detection

With 864 channels and about 130,000 quick acquisition correlators in our TRIUMPH chip, we have resources to assign more than one channel to each satellite to find ALL signals that are transmitted with that GNSS satellite PRN code.

If we detect more than one reasonable and consistent correlation peak for any PRN code, we know that we are being spoofed and can identify the spoofed signals.

When we detect that spoofing is in effect, we use the position solution provided by all other clean signals (L1, L2, L5, etc... GPS, GLONASS, Galileo, Beidou, etc...) to identify the spoofer signal and use the real satellite measurement. If all GNSS signals are spoofed or jammed, then we alarm you to ignore GNSS and use other sensors in your integrated system.

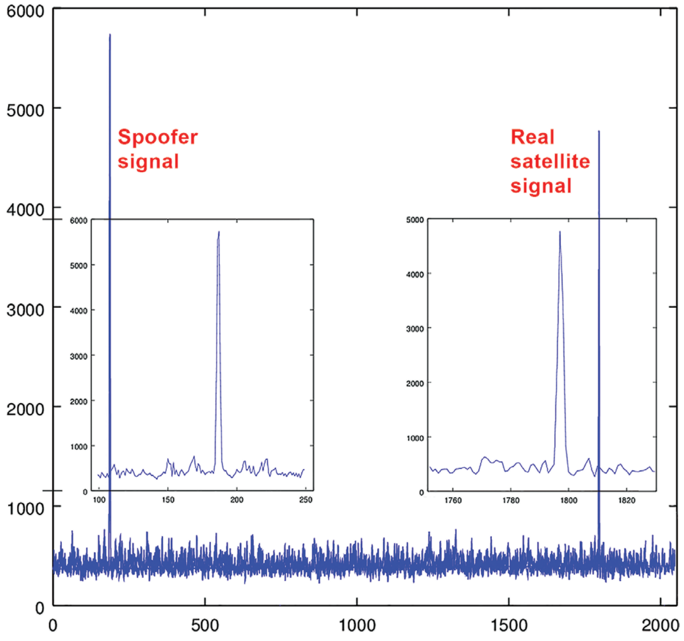


Figure 1
shows an example of a spoofer signal and a real satellite signal received at GNSS receiver.

Satellite and Spoofer Peaks

The screenshots below are from a real spoofer in a large city. The bold numbers are for the detected peaks. The gray numbers represent highest noise, not a consistent peak. "*" symbol next to the CNT numbers indicate that signal is used in position calculation. Each CNT count represent about 5 seconds of continuous peak tracking.

SAT	EL	S...	Range 1	Dopp...	CNT 1	S...	Range 2	Dopp...	CNT 2	dRng	dDop	N
GPS5	33	16	61.14	1382	184*	4	25.95	181	1	29.32	1201	29
GPS7	51	21	14.39	1146	184*	4	18.21	-453	1	2.80	1599	29
GPS8	30	18	65.10	-918	184*	4	4.26	-1318	1	3.68	400	29
GPS9	12	14	40.46	2966	184*	4	2.08	3765	1	26.13	-799	29
GPS13	40	16	46.92	-3525	184*	4	8.21	-4325	1	25.80	800	29
GPS15	12	14	12.46	-4336	30*	5	33.00	-1536	1	19.52	-2800	28
GPS20	24	12	13.19	-1707	107*	4	29.32	-3307	1	15.11	1600	29
GPS27	16	11	10.26	1264	184*	4	43.55	63	1	31.22	1201	29
GPS28	53	19	9.41	-2724	184*	4	7.93	-4724	1	0.46	2000	29
GPS30	81	22	13.79	-332	184*	5	34.16	1266	1	19.35	-1598	28
GLN-4	54	20	62.08	1498	1158*	5	21.72	2697	1	24.16	-1199	25
GLN5	46	20	18.04	-2897	524*	4	26.26	-3697	1	7.20	800	25
GLN0	37	18	30.37	2355	1469*	4	38.37	1554	1	6.98	801	25
GLN-1	82	18	34.92	-776	189*	4	12.54	-1576	1	21.35	800	25
GLN-2	26	12	30.96	-4358	229*	4	11.80	-3158	1	18.13	-1200	25
GLN2	21	10	59.73	288	551*	4	47.55	1087	1	11.16	-799	25
GLN4	22	15	30.59	-3361	208*	4	11.74	-5361	1	17.83	2000	25
GLN-5	21	14	20.17	276	187+	3	25.45	2275	1	4.26	-1999	25

Esc Sat: 10 7 6 4 4 0 dPos: 19.0m Age: <1s

Figure 2 *No spoofer. Only one reasonable peak for each satellite.*

Elevation Angle
Satellite Name
Signal above noise level | Range mod 1 ms | Doppler | 5 sec count — First Peak
Signal above noise level | Range mod 1 ms | Doppler | 5 sec count — Second Peak
Delta range | Delta Doppler | Noise level

SAT	EL	S...	Range 1	Dopp...	CNT 1	S...	Range 2	Dopp...	CNT 2	dRng	dDop	N
GPS1	**14**	**14**	**231.08**	**-2627**	**140***	**9**	**155.13**	**-2627**	**60**	74.93	0	28
GPS10	9	**12**	**267.44**	**-2078**	**74***	4	238.41	-3278	1	28.01	1200	28
GPS11	22	**13**	**297.36**	**-847**	**301***	3	6.45	1151	1	289.89	-1998	29
GPS13	**55**	**21**	**136.95**	**1154**	**301***	**9**	**21.70**	**1153**	**73**	114.23	1	28
GPS15	**49**	**20**	**278.00**	**-453**	**301***	**9**	**168.03**	**-453**	**73**	108.95	0	29
GPS17	**41**	**22**	**83.28**	**-3212**	**301***	**10**	**277.41**	**-3212**	**69**	193.11	0	28
GPS19	**23**	**14**	**133.13**	**-4590**	**164***	**7**	**19.06**	**-4590**	**69**	113.05	0	29
GPS20	5	**8**	**170.96**	**2215**	**36***	3	50.73	614	1	119.21	1601	29
GPS24	**22**	**15**	**54.25**	**-4022**	**177***	**9**	**250.43**	**-4022**	**82**	195.16	0	29
GPS28	58	**18**	**50.14**	**1040**	**301***	3	268.62	1439	1	217.46	-399	29
GPS30	23	**17**	**290.02**	**2593**	**301***	3	214.66	4592	1	74.34	-1999	28
GLN-7	30	**22**	**159.09**	**2505**	**213***	7	274.16	2104	1	114.05	401	28
GLN-4	39	**18**	**72.21**	**-450**	**282***	7	220.15	-3250	1	146.92	2800	28
GLN-1	34	**18**	**92.17**	**-3838**	**259***	6	299.41	-1838	1	206.22	-2000	28
GLN0	72	**23**	**271.81**	**147**	**283***	7	78.08	2146	1	192.71	-1999	28
GLN1	23	**15**	**297.65**	**3244**	**129***	6	8.21	2443	1	288.42	801	28
GLN2	42	**18**	**200.78**	**-742**	**282***	6	234.83	2056	1	33.03	-2798	28
GLN3	17	**18**	**158.51**	**2584**	**282***	6	44.03	4583	1	113.46	-1999	28

Esc Used: 11+9+4+8+0+1=33 | 1 | 2 | dPos: 21.2m Age: <1s

GPS GLN GAL BDU IRN QZ ◄ Number of satellites used in position calculation

Figure 3
In the screenshot all GPS satellites have two peaks and all are spoofed. We were able to distinguish the spoofer signal and use the real satellite signals in correct position calculation as indicated by the "" next to the CNT numbers.*

PATENTS PENDING

VB-RTK

Get on the Grid with VB-RTK. For over a decade American surveyors have been using the National Geodetic Survey's Online Positioning User Service. Surveyors employing RTK have been a significant share of the user segment of OPUS.

A significant share of OPUS users are surveyors using RTK. Often a surveyor will set up his base on a new, unknown position and allow an autonomous (or standalone) position to be used for the base coordinates. While he is performing his RTK work with fixed vectors between his base and rover, he stores data at the base to be submitted at a later time to OPUS. Once he is finished with his work, he downloads this file to his computer, converts the file if necessary, and submits it to OPUS. He then receives an email response back with a precisely determined coordinate for his base station. He then must take this coordinate, relate the coordinate to his project coordinate system, and then translate the work from the autonomous (or standalone) position he used in the field to this new coordinate. This procedure can produce excellent results and anchors the survey to the NSRS. The down side to this is that there are several steps that must be carefully observed and each of these error prone steps costs time.

With J-Field data collection software, Javad has been automating many tasks that surveyors have been doing for years, making the tasks more efficient and reducing sources of potential error. One example, **"Verify RTK with V6 Resets"**, is being recognized by surveyors across the country as the most accurate and efficient way to confidently determine RTK positions. Rather than taking a shot, manually resetting (or dumping) the receiver and taking a second shot for comparison, Verify RTK does this automatically with a user defined number of reset iterations.

Javad has continued this automation philosophy by dramatically simplifying the process of translating a survey from an autonomous base position to precise geodetic coordinates with **VB-RTK (Verify Base – RTK)**. Using the Javad GNSS, Data Processing Online Service (DPOS), which is powered by the proven Javad GNSS Justin processing engine. **This multi-level process is done in J-Filed completely automatically.**

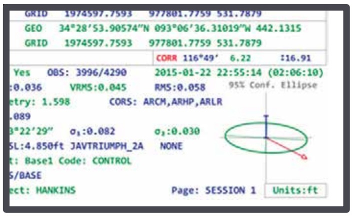
Once an RTK session has been completed, the user returns to his Javad base receiver and presses "Stop Base" on the Triumph-LS. **At this point, the raw data file that has been recording at the base during the session, is wirelessly downloaded from the base to the Triumph-LS. When the download is complete, the user returns to his office and connects the Triumph-LS to the internet.**

When internect connection is made, the file is automatically transmitted to one of the Javad GNSS servers for post processing. Once data and ephemerides are available for the session, **DPOS** processes the file and returns results to the waiting Triumph-LS. This all takes place within minutes.

Once results are returned, the new coordinates for the base are shown related to your coordinate system (including localization systems).

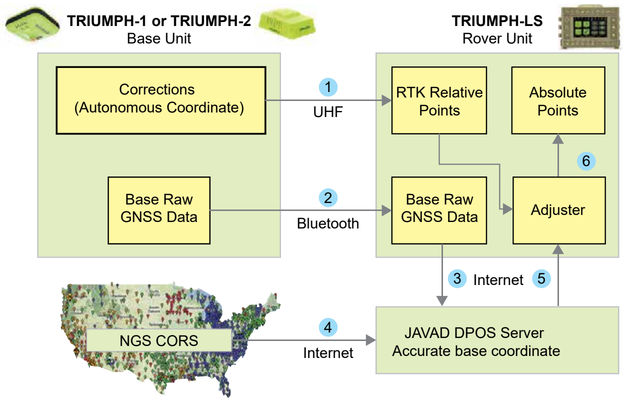
The horizontal and vertical differences between the base coordinates used and the DPOS determined coordinates are shown. **This provides for an instant check of the base coordinates and instrument height** if the base were set up on a known position.

All rover points associated with that base session translate automatically in seconds. Only those rover points associated with that base session translate.

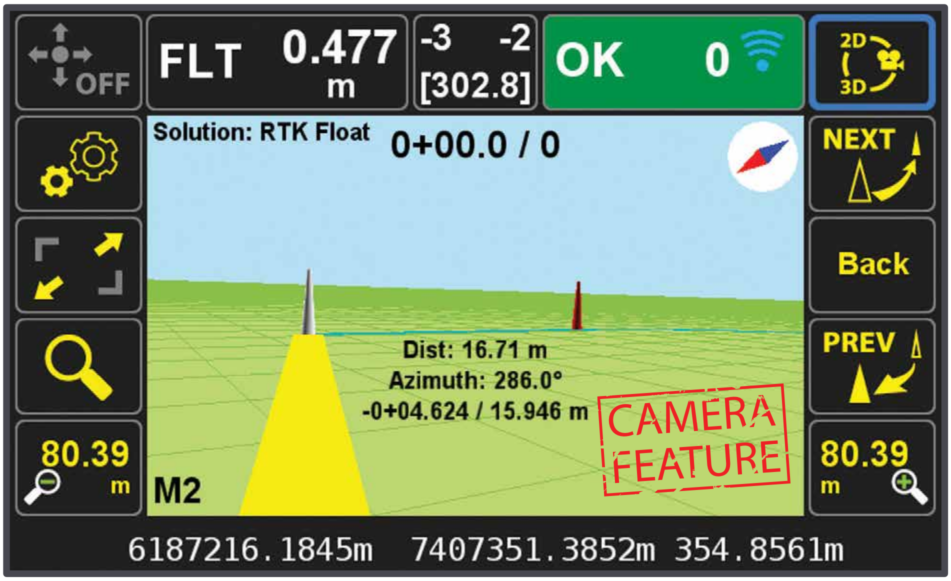


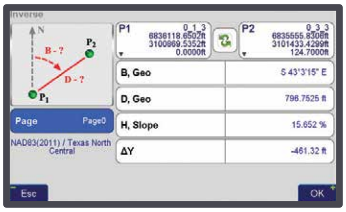
If the user is not satisfied with the results of the DPOS solution and wants to revert back to the original RTK positions, he simply clicks **"Undo"**. This process is immune to base instrument height errors because the internal vectors between base to rover are related to the antenna, not the ground point. So, an accidental entry for the base height of 543' instead of 5.43' can be resolved by VB-RTK.

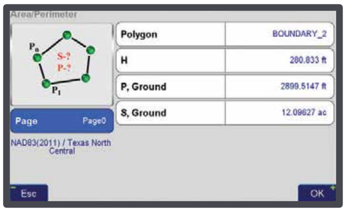
In addition to the advantages of having your RTK base station near your work area, which gives you much more accurate and faster fixes, especially in difficult areas, and saving you the RTN fees; perhaps most important of all, your work is now precisely related to one of the most accurate geodetic control networks in history – the NGS CORS. Every rover point is only two vectors removed from the CORS (CORS to base, base to rover). This means that you can return again someday to find your monuments easily and accurately. This makes your records incredibly more valuable to both you and future surveyors. J-Field also has the unique ability to load and view every point you have ever surveyed from all the projects in its system. By combining this feature with a **distance filter** in its advanced set of filters, you can easily view all the points you have previously surveyed within a given distance of a point in your current project. Having an easily accessible record of nearby georeferenced coordinates is very beneficial as you may have previously located monuments in past surveys that are beneficial in your current project. J-Field allows you to easily copy these selected points into your current project, eliminating the need for you to resurvey them. All of this is available automatically on the world's most advanced RTK rover – **the Triumph-LS**.

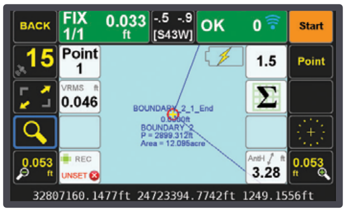


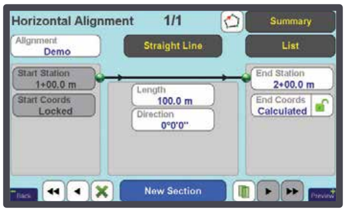
You do 1, the rest is automatic











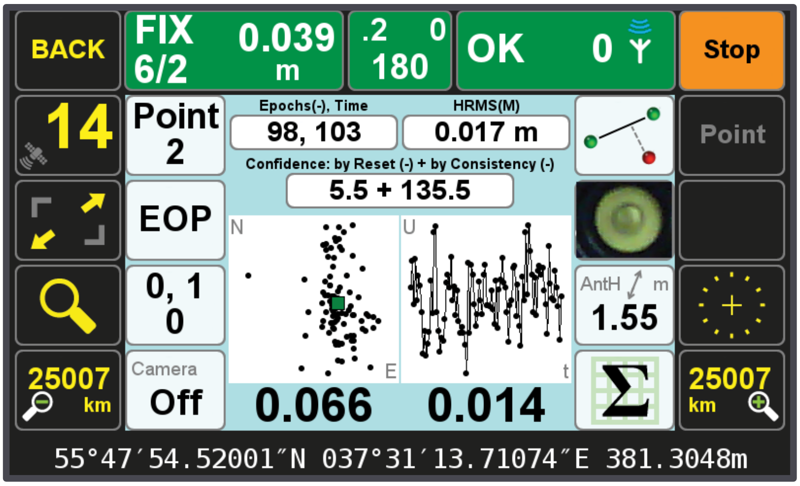
Store and Stake

Introducing GUIDE data collection in the TRIUMPH-LS. Visual Stake-out, navigation, six parallel RTK engines, over 3,000 coordinate conversions, advanced CoGo features, rich attribute tagging on a high resolution, large, bright 800x480 pixel display. Versatile attribute tagging, feature coding and automatic photo and voice documentation.
The TRIUMPH-LS automatically updates all firmware when connected to a Wi-Fi internet connection.

View and Document your level

The downward camera of TRIUMPH-LS scans and finds the liquid bubble level mounted on the pole. Then focuses on the circular bubble automatically and shows its image on one of the eight white buttons of the Action Screen. You can:

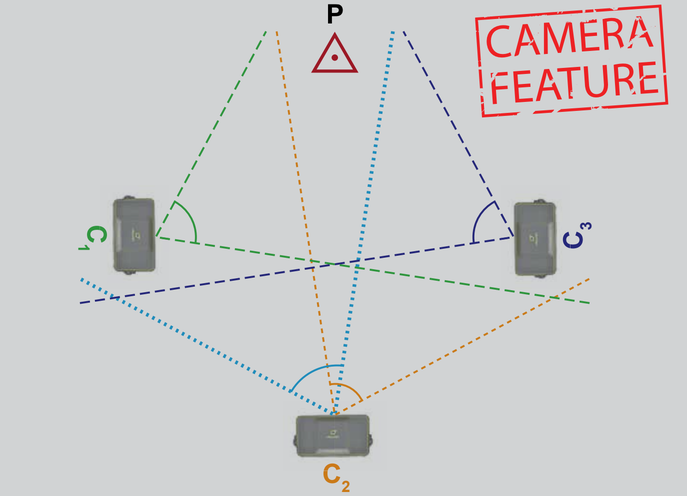
- View the liquid bubble level on the screen.
- Document survey details including the leveling by taking automatic screen shots of the Action Screen, as shown here.
- Calibrate the electronic level of TRIUMPH-LS with the liquid bubble level for use in Lift and Tilt and automatic tilt corrections.

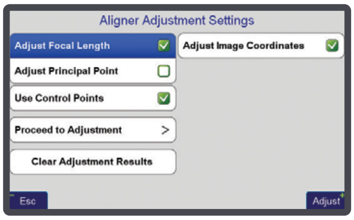


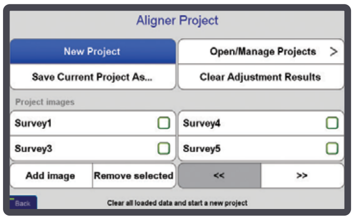
All these camera features are possible only in TRIUMPH-LS where camera, and GNSS antenna are co-located and all other modules integrated.

Offset Survey with built in camera

You can survey points with internal TRIUMPH-LS camera with accuracy of about 2 cm. Take pictures from at least three points. Leave a flag on points that you take pictures from, otherwise accuracy will be about 10 cm.





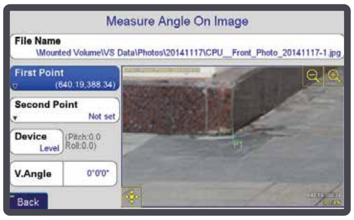


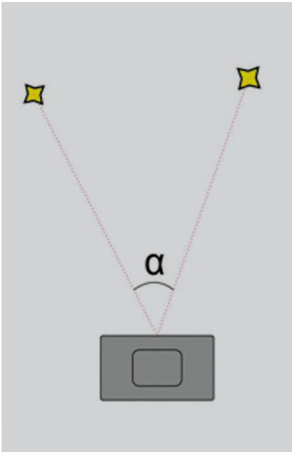
Visual Angle Measurement with Triumph LS

The new Visual Angle Measurement function of the TRIUMPH-LS allows measuring angles between points by using photos taken by the TRIUMPH-LS camera and use in CoGo tasks with the Accuracy of about 10 angular minutes.

To measure an angle:

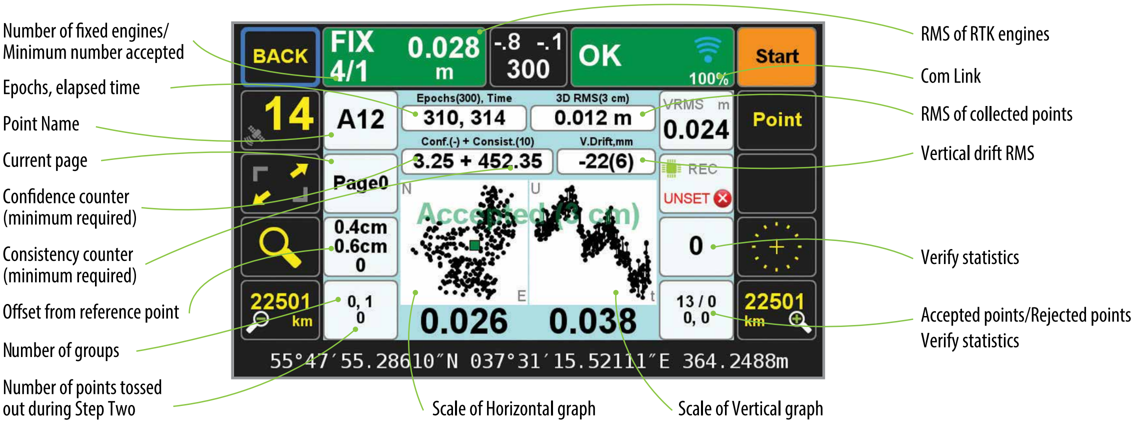
- just take an image containing both objects of interest and open it in the Measure Angle screen
- select first and second point (using zoom to focus on necessary features)
- The angle between points is immediately displayed on the screen.



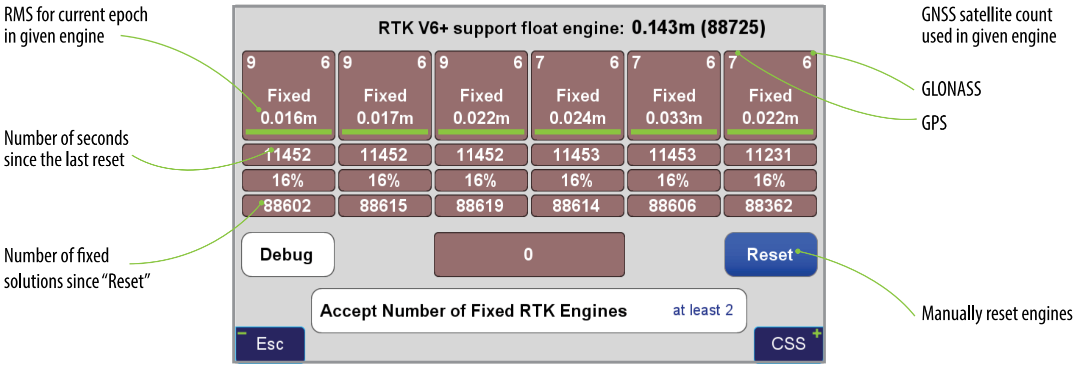


RTK V6+

six engines plus one support



Auto Verify... Auto Validate...



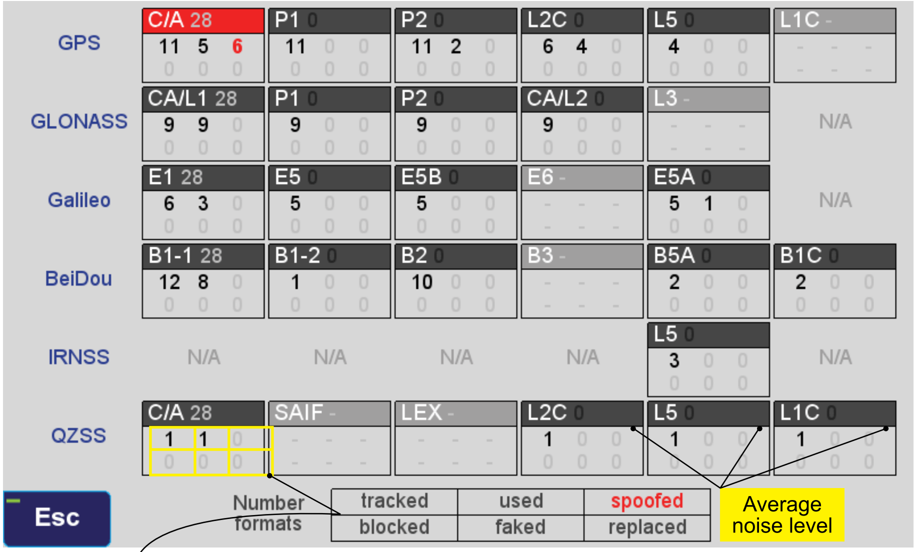
This vigorous, automated approach to verifying the fixed ambiguities determined by TRIUMPH-LS gives the user confidence in his results and saves considerable time compared to the methods required to obtain minimal confidence in the fixed ambiguity solutions of other RTK rovers and data collectors on the market today. The methods required by other systems are not nearly so automated, often requiring the user to manually reset the single engine of his rover, storing another point representing the original point and then manually comparing the two by inverse, all to achieve a single check on the accuracy of the fixed ambiguities. Acquiring more confidence requires manually storing and manually evaluating more points. Conversely, J-Field automatically performs this test, resetting the multiple engines, multiple times (as defined by the user), provides an instant graphic display of the test results, and produces one single point upon completion.

Read details inside and compare with other receivers that require Multiple Point survey, Manual Evaluation, Single Engine, and Single Ambiguity Check per Point.

With TRIUMPH-LS you have Single Point survey, Automated Evaluation, Multiple Engines, and Multiple Ambiguity Checks per Point.

GNSS Overall View

The format and the signal definitions are explained below.



GPS L2C: L+M
GLN L3: I+Q
GAL E1: B+C
GAL E5: alboc
GAL E5B: I+Q
GAL E5A: I+Q
BeiDou B2: B5B
QZSS L2C: L+M
QZSS L1C: I+Q

Figure 4
The screenshot shows the status of all GNSS signals.

Definitions for the number of signals:

Tracked: Tracked by the tracking channels and has one valid peak only.

Used: Used in position calculation.

Spoofed: Has two peaks. Good peak is isolated, if existed.

Blocked: Blocked by buildings or by jamming. If jammed, shows higher noise level.

Faked: Satellite should not be visible, or such PRN does not exist.

Replaced: Real signal is jammed and a spoofed signal put on top of it. Because of jammer, it shows higher noise level.

Spoofer Orientation

When you detect that spoofers exist, you can also try to find the direction that the spoofing signals are coming from. For this, hold your receiver antenna (e.g. TRIUMPH-LS) horizontally and rotate it slowly (one rotation about 30 seconds) as shown in the picture and find the direction that the satellite energies become minimum. This is the orientation that the spoofer is behind the null point of the antenna reception pattern.

After one or more full rotations observe the resulting graph that shows approximate orientation of the spoofer as shown in figure 5.

Number of Satellites

Direction of minimum

Total SNR

Direction of minimum

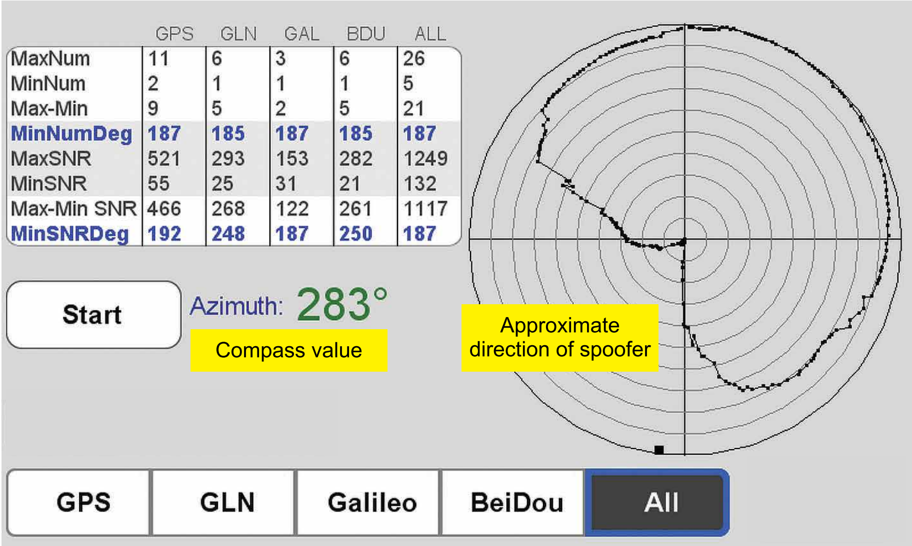


Figure 5
This screenshot is from the experiment within an anechoic chamber. That is why the picture is clean and smooth.

$850

J-Tip

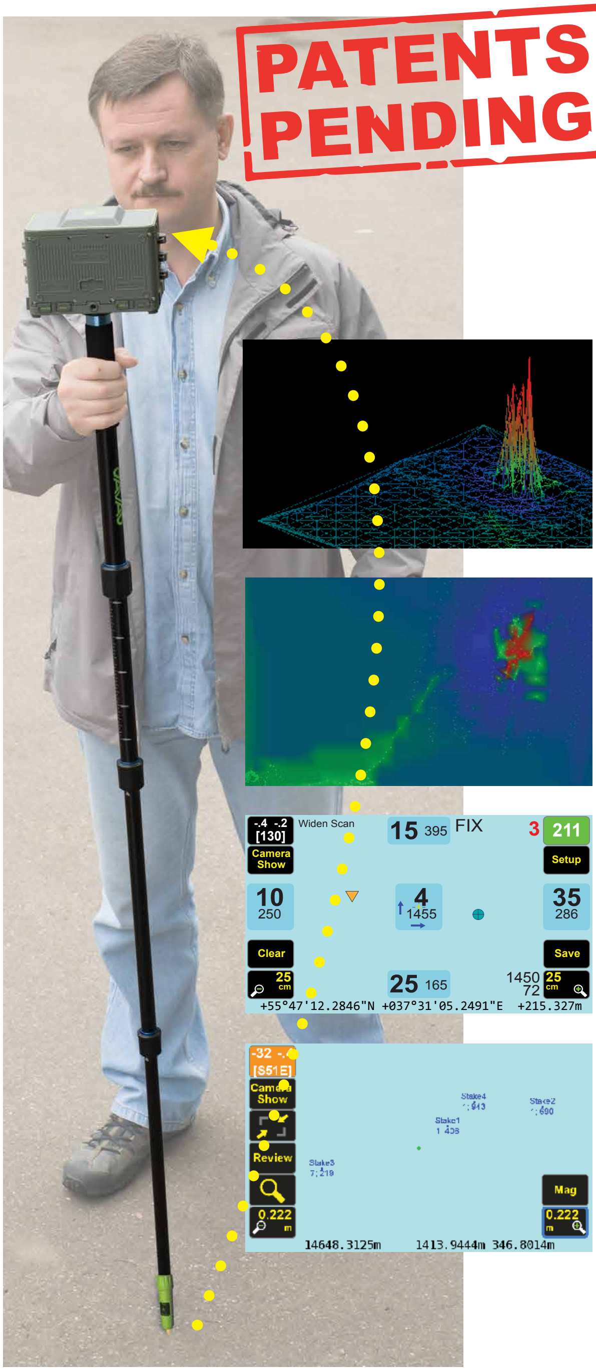
Integrated Magnetic Locator

No need to carry heavy magnetic locators any more. The J-Tip magnetic sensor replaces the tip on the bottom of your rover rod/monopod. Its advanced magnetic sensor send 100 Hz magnetic values to the TRIUMPH-LS via Bluetooth. TRIUMPH-LS scans the field and plots the 2D, 3D and time view of magnetic characteristics. It also shows the shapes and the centres of the objects under the ground and guides you to it.

J-Tip advantages:

- J-Tip does not have “null” points around the peak and will not produce false alarms.
- J-Tip is fully automatic for all levels of magnets. Audio tones self adjust. There is no “Gain” button to adjust.
- J-Tip senses the mag values in all directions. You don’t need to orient it differently in different searches.
- J-Tip gives a 2D and 3D view of the field condition when you have RTK and will guide you to the object. You can actually see the shape of buried object.
- J-Tip, In Time View, shows positive and negative mag values of the last 100 seconds and the Min and the Max since Start.
- J-Tip shows the instantaneous magnetic vector in horizontal and vertical directions.
- J-Tip works as a remote control for the TRIUMPH-LS
- J-Tip weighs 120 grams and replaces the standard pole tip. In balance, it weighs almost nothing.
- The built in camera of the TRIUMPH-LS documents the evidence after digging.
- And... you don’t need to carry another bulky device.

PATENTS PENDING



Developing a global framework for unmanned aviation

ICAO published the first edition of the Manual on Remotely Piloted Aircraft Systems (Doc 10019) in March 2015

Philip Dawson
Consultant, RPAS
Air Navigation Bureau
International Civil
Aviation Organization

Unmanned aircraft systems (UAS) and RPAS represent a new and challenging component of the work programme of the International Civil Aviation Organization

In the *Convention on International Civil Aviation* (Doc 7300) (Chicago Convention), signed at Chicago on 7 December 1944, any aircraft intended to be flown without a pilot on board is referred to as a "pilotless aircraft". Today, these aircraft are called "unmanned" rather than "pilotless". Unmanned aircraft (UA) include a broad spectrum from meteorological balloons that fly freely to highly complex aircraft piloted from remote locations by licensed aviation professionals.

The latter are part of a category referred to as remotely piloted aircraft (RPA) and operate as part of remotely piloted aircraft system (RPAS). RPAS, which offer a vast range of capabilities and sophistication, constitute a growing industry with considerable operational opportunities and economic potential. In addition to RPA, a range of new aviation activities have been gaining momentum recently. These include small UA commonly referred to as "drones" as well as new developments such as "flying taxis", operating along with existing airspace users like manned helicopters, paragliders and other aircraft.

However, since their associated technologies, designs and operating concepts are evolving rapidly, States are being challenged with the safe and efficient integration of RPAS and UAS into environments shared by a highly regulated and well established manned aircraft. As such, unmanned aircraft systems (UAS) and RPAS represent a new and challenging component of the work programme of the International Civil Aviation Organization (ICAO).

ICAO is actively involved in facilitating the development of a regulatory framework for unmanned aviation and in leading the discussion on RPAS and UAS through the organization of global symposia.

Remotely piloted aircraft systems panel (RPASP)

To assist its efforts, ICAO established the Unmanned Aircraft Systems Study Group (UASSG) in 2007 to support the development of Standards and Recommended Practices (SARPs) and guidance material for civil UAS. In 2014, the RPAS Panel (RPASP) was established to progress the work of the UASSG with the following objectives and scope:

a) serve as the focal point and coordinator of all ICAO RPAS related work, with the aim of ensuring global interoperability and harmonization;
b) develop SARPs, procedures and guidance to facilitate safe, secure and efficient integration of RPA into non-segregated airspace and aerodromes;
c) review ICAO SARPs, propose amendments and coordinate the development of RPAS related SARPs with other ICAO expert groups;
d) assess impacts of proposed provisions on existing manned aviation; and
e) coordinate, as needed, to support development of a common position on bandwidth and frequency spectrum requirements for command and control of RPAS for the International Telecommunications Union (ITU) World Radio Conference (WRC) negotiations.

ICAO published the first edition of

the *Manual on Remotely Piloted Aircraft Systems* (Doc 10019) in March 2015. The purpose of the Manual is to provide guidance on technical and operational issues applicable to the integration of RPA in non-segregated airspace and at aerodromes.

Annexes to the Chicago Convention

In order to develop a regulatory framework for unmanned aviation, one must first be familiar with the existing framework that was built piece by piece as aviation grew. To this end, the RPASP is thoroughly involved in a detailed study of the Chicago Convention and its 19 Annexes.

It is anticipated that all but one of the 19 Annexes will be amended to accommodate RPAS requirements. Annex 5 — *Units of Measurement to be Used in Air and Ground Operations* will not be affected. Thus far, the Panel's work has led to the following amendments. Annex 2 — *Rules of the Air*, now contains high level Standards regarding certification, licensing, operating rules and special authorizations as required under Article 8 of the Chicago Convention, which provides that: "*No aircraft capable of being flown without a pilot shall be flown without a pilot over the territory of a contracting State without special authorization by that State and in accordance with the terms of such authorization*". Annex 7 — *Aircraft Nationality and Registration Marks*, defines RPA as unmanned aircraft, and ensures nationality and registration marks can be applied regardless of size or configuration of aircraft. Annex 13 — *Aircraft Accident and Incident Investigation*, extends the definition of "accident" to include unmanned aircraft.

More recently, the RPAS Panel has developed new provisions for the remote pilot licence (RPL) for remote pilots, student remote pilots and instructor ratings, medical assessments, as well as licences and ratings for personnel other than remote flight crew members. After a thorough analysis of the role and functions of the RPL and the broad range of RPAS, the Panel recommended that only one licence, with appropriate endorsements (class, category and type rating of RPA and associated Remote Pilot Stations (RPS), operational limitations, etc.), would best accommodate the diversity of current and future requirements. This licence has been created on the same basis as that of a commercial pilot for manned aviation.

Accordingly, ICAO adopted in March 2018 an amendment to Annex 1 – *Personnel Licensing*, which introduced a regulatory structure for the issuance of RPL and the provision of a global framework for the regulation of RPAS licensing to support international flights operating under instrument flight rules (IFR). To assist States with the implementation of these new provisions, ICAO is assembling a multidisciplinary group of global experts to review and make consequential updates to related ICAO guidance material. Given the critical role that competent personnel play in ensuring operational safety, the guidance material developed by this group of experts will help to ensure that States can properly approve and oversee their service providers' training programmes in advance of the amendment applicability date of 2 November 2022.

The RPAS Panel is actively progressing work on amendments to the remaining Annexes. In particular, Annex 6 – *Operation of Aircraft*, will contain a brand new Part IV — *International Operations — Remotely Piloted Aircraft Systems* covering all types of RPA, with no distinction between commercial and general aviation, as well as requirements for the RPAS operator certificate. Annex 8 — *Airworthiness of Aircraft* will be expanded to cover RPS and C2 Link for control and management. Annex 10 — *Aeronautical Telecommunications* will contain provisions for C2 Link, frequency spectrum, as well as detect and avoid capability. Future amendments to Annex 11 — *Air Traffic Services* will relate to the integration of RPAS into the air traffic management (ATM) system. Annex 17 — *Security* will include measures to prevent unlawful interference, particularly related to physical security of RPA and RPS. Provisions in Annex 18 — *The Safe Transport of Dangerous Goods by Air* will be extended to address RPA employed to carry dangerous goods. The scope of Annex 19 — *Safety Management* will be extended to actors engaged in the RPAS industry (e.g. operators, other service providers).

It should be noted that many of the Annexes will require more than one amendment to fully address the safe and efficient integration of RPAS.

Unmanned aircraft systems (UAS)

In 2015, it was recommended during ICAO's High-level Safety Conference that the Organization provide supporting material to assist States in the mitigation of risks posed to international flights from RPA and UA.

In 2016, the ICAO Assembly expanded the scope of the Organization's work programme to include the regulation of UA beyond IFR international operations. The focus of this expansion would be particularly on UA weighing up to 25 kg, most of which conduct domestic operations. These operations are conducted for commercial, professional or recreational purposes; however the aircraft do not, and normally cannot, meet the strict standards applying to commercial aviation operations. In order to safely regulate these activities, the Assembly advised that an innovative and flexible approach should be adopted, taking into account ongoing developments at national, regional and international levels.

The unmanned aircraft systems advisory group (UAS-AG)

The UAS-AG was established in 2016 to provide guidance and best practices to States, regulatory bodies and stakeholders. The UAS-AG is comprised of a multidisciplinary membership of UAS regulatory and operational personnel, ATM and related industry technical experts from geographically diverse Member States, international organizations, industry and academia.

The UAS-AG developed an online Toolkit to assist States that have no, or limited, regulations or guidance material, and to enable UAS operations in a safe manner. The Toolkit offers not only helpful information and resources, but also serves as a platform for the exchange of global best practices, lessons learned, and effective governance approaches. The Toolkit is accessible at the following link: https://www.icao.int/safety/UA/UASToolkit/Pages/default.aspx.

UAS Traffic Management (UTM)

UTM is a concept being developed that would serve as a more automated ATM like system for areas with high density UA operations, including package delivery, public safety, infrastructure inspections, etc. Initially UTM is planned to include low altitude airspace where manned aircraft (such as low flying helicopters) could be affected.

Recognizing that a variety of UA are set to be used in lower-level domestic airspace for professional or recreational flights, consumer deliveries, urban mobility and many other uses still to be imagined, ICAO announced in May 2017 a Request for Information (RFI) calling for solutions from industry, States and stakeholders to establish a common global framework for UTM. In particular, submitters were asked to provide their views on solutions for the following three components of UTM:

a) the registration system from which data is accessible in real time to allow remote identification and tracking of each UA, its operator/owner and location of the remote pilot/control station. To accommodate UA that are increasingly transported from one State to another for either recreational or professional use, this database should allow global access;
b) communications systems for control and tracking of UA within the UTM area. The communications system used for tracking UA must be able to identify when a manned aircraft is entering UTM airspace and provide an acceptable level of protection between it and UA operating in the airspace. Furthermore, it must facilitate detection of potential collisions with other UA and with obstacles such that appropriate avoidance action can be taken; and
c) geofencing-like systems that will support automatic updates by national authorities on the 28 day aeronautical information regulation and control (AIRAC) cycle to prevent UA operation in sensitive security areas and restricted or danger areas such as near aerodromes.

As the development of UTM moves forward, ICAO is focusing on the next evolution of the ability for aircraft (both manned and unmanned) to safely and efficiently transition between any future UTM system and the concurrent ATM systems. The primary requirement is to ensure safe integration, without negatively impacting manned aviation or the safety of persons and property on the ground, taking into account security and equal accessibility for all airspace users. Understanding the boundaries and the transition phases between these systems, how they interact and how best to exchange essential information will enable States, regulators and industry to continue to advance this global industry while preserving safety of all airspace users.

ICAO received a total of 76 responses from industry, States and other stakeholders. Building on the success of the first RFI initiative, ICAO announced in February 2018 a second RFI seeking practical solutions for describing the ATM/UTM boundaries, the transition between the boundaries and the capabilities needed by each system to allow for secure and efficient operations. The deadline for submission has been set for 30 April 2018. For more information please visit: https://www.icao.int/safety/UA/Documents/State%20letter%2018-26%20RFI.pdf

The UAS-AG is in the process of developing a UTM global harmonization document based on the first RFI submissions and will be incorporating the proposals from the second round of RFI submissions in due course.

ICAO's unmanned aviation symposia

In September 2017, ICAO hosted the Second Global RPAS Symposium under the theme of *Licensing Training and Operator Responsibilities: Initial Steps for RPAS/UAS Entrance into the ATM Environment*. The meeting provided an opportunity for States, international organizations and other stakeholders to gain a more detailed understanding of the roles and responsibilities of RPAS operators, airspace managers, training facilities, licensing authorities, regulators and industry towards ensuring safe operations. In addition, participants were briefed on the operational impact of human performance and how safety management principles support early accommodation. ICAO also held DRONE ENABLE, its first ever UAS Industry Symposium. Leading experts from academia, industry, States and international organizations presented their perspectives on solutions for domestic UA operations and for a common UTM framework, with particular focus on necessary registration, communications and geofencinglike systems.

The Third Global RPAS Symposium and the Second DRONE ENABLE event will be held in September 2018 in Chengdu, China. These meetings will explore the following themes: *From Accommodation to Integration*; and *UTM to ATM – Transitioning from Segregation to Integration*. A selection of top submission authors will present their solutions regarding the UTM-ATM interface. Discussion will focus on complex issues such as categorization for RPAS operations as well as UTM. In addition, the events will provide a unique opportunity to assess the status of regulations currently used in various parts of the world. Through these activities, ICAO plays the leadership role as the global facilitator for the development of a comprehensive and harmonized regulatory framework for unmanned aviation.

Land parcel 3D mapping using terrestrial laser scanning

This article is about the 3D mapping areas of parcel by the method of Terrestrial Laser Scanning (TLS) for the purposes of coastal management that is required by the Government of DKI Jakarta

Hendriatiningsih SADIKIN
Faculty of Earth Sciences and Technology, Institute Technology of Bandung, Bandung, Indonesia

Heri ANDREAS
Faculty of Earth Sciences and Technology, Institute Technology of Bandung, Bandung, Indonesia

Andika P SUHERMAN P
Faculty of Earth Sciences and Technology, Institute Technology of Bandung, Bandung, Indonesia

Laser scanning is one of the latest techniques applied in 3D survey and mapping. Currently it is the leading survey technology providing spatial data information. Laser scanning is a process of recording precise 3D information of real world objects or environments. There are many types of measuring instruments that use laser scanning technology with a range of capabilities for a variety of applications (Staiger, R., 2003). Heinz Stanek (2004), stated that applications of lasers scanners are successful in wide areas of documentation of surfaces and objects. Almost, the general principle of data acquisition must be optimized in specific ways. For the data acquisition the demanded precision and density, but also the number and distribution of reference points may vary.

According to Jagannath Hiremagalur *et.al* (2009), TLS measure thousands of data points (distance, angle, and reflected return signal power) per second and generate a very detailed "point cloud" data set. Using TLS will dramatically improve safety and efficiency over conventional survey methods. However, to fully realize the benefit of using TLS, they must be used properly and in appropriate applications. Mike Pinkerton, (2010) stated that how Terrestrial Laser Scanning solutions have been applied on projects where up until very recently traditional surveying methods would have been the norm. As more people are made aware of the benefits of laser scanning, then their expectations from their spatial data suppliers will rise accordingly. Concurrent with this change in attitude will be ongoing further refinement of technology (both hardware and software). The end result will be that laser scanning technology, like real time GPS did before it, will inevitably become commonplace within the realm of mainstream land surveying. According to R H Alkan and G Karsidag (2012), data obtained from laser scanner has a high quality and widely used in various fields, particularly those surveys that include topographic surveys, environmental and industrial.

The main advantage of mapping surveys using laser scanning technology, can provide complete facilities to perform data acquisition and can give detailed data in 3D, as well as the results can be obtained quickly dam costs could be reduced significantly. Laser scanning technology is one of the latest techniques in 3D mapping and survey technology is the latest survey to obtain information on the spatial data. There have been many kinds of measuring instrument that uses laser scanning technology with a range of capabilities. In the field of survey mapping, laser scanning equipment is a new dimension in spatial data collection (Sadikin Hendriatiningsih *et.al*, 2014). This article is about the 3D mapping areas of parcel by the method of Terrestrial Laser Scanning (TLS) for the purposes of coastal management that is required by the Government of DKI Jakarta. In this study, the building height is measured from georeferenced 3D models.

Methods and results

The equipment used is TLS Optech ILRIS Model 36D, the prism used as targets, computer, software Polywork, Geomagic Studio 2013, AutoCAD, Google SketchUp, and accessory equipment for completeness. Location GPS control points in the area of Pantai Mutiara, as in Figure 1, as follows:

The control points are in zone 48 S in the UTM projection system, and the coordinate data points that the GPS control point NRP_1, NRP_2, and NRP_3 are shown in Table 1.

The next is to plan the placement of TLS instrument for scanning. Field of view of the equipment TLS is 40 ° x 40 °, then scanning the object consists of four sections in one place standing instrument TLS with overlap of 4 °. Scanning from the roof of the apartment as shown in Figure 2.

To complete the area being scanned from the roof of the apartment, the next scan is done on the road (from the street) to complete the data scanning. Scanning from the street to the prism point location, as shown in Figure 3.

TB = TLS location
P = Prism point location

Data processing point clouds to get a 3D solid model is doing some stage, namely registration, filtering, georeferencing, and modeling.

The registration process carried out by separating the registration based on the location decision, namely the registration scanning from the roof of Apartment and from the street. Then the two registrations are combined to form complete object. The registration model can be seen in Figure 4.

And the average registration error is 0.0191 m.

Filtering is delete for unnecessary data. This is done by manual, by identifying the objects that are not necessary, then the objects been removed. Before filtering, as shown in Figure.5. And after filtering, shown in as Figure 6.

Next, calculate the undulation and orthometric elevation of GPS control points, and the results are as shown in Table 2.

Table 1. GPS Control points coordinates (A P Suherman P, 2014)

ID Number	Latitude (° ′ ″)	Longitude (° ′ ″)	h Ellips (m)	East UTM (m)	North UTM (m)
NRP_1	06 06 01.9896 S	106 47 25.5396 E	18.831	698140.741	9325351.016
NRP_2	06 06 10.4719 S	106 47 29.7328 E	18.795	698268.818	9325090.000
NRP_3	06 06 05.6357 S	106 47 42.7376 E	18.429	698669.218	9325237.245

Figure 1. Location of GPS control points in Pantai Mutiara (A P Suherman P, 2014)

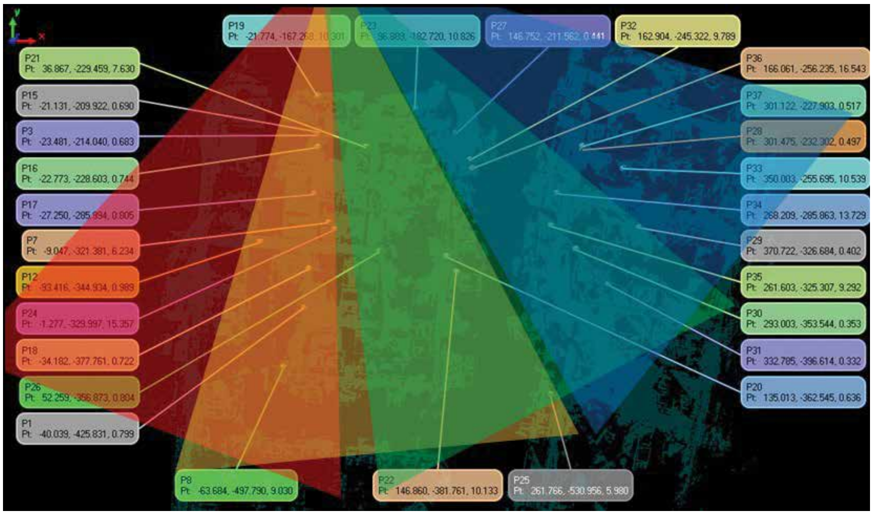


Figure 2. Scanning from the roof of the Apartment (A P Suherman P, 2014)

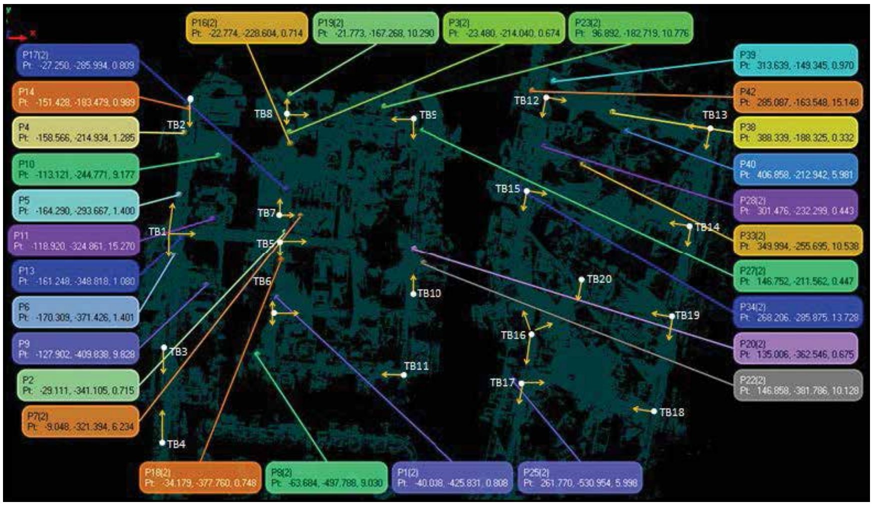


Figure 3. Scanning from the street (A P Suherman P, 2014)

Figure 4. Regristration model (A P Suherman P, 2014)

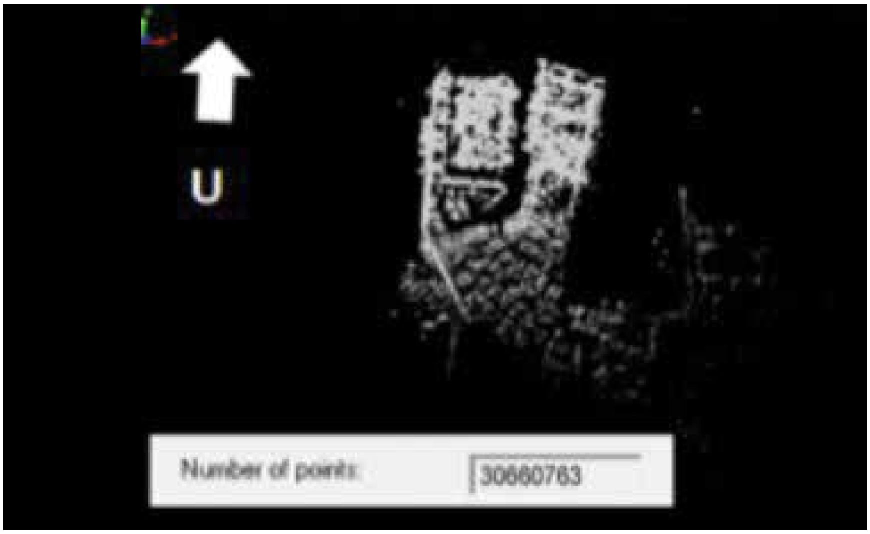


Figure 5. Before filtering (A P Suherman P, 2014)

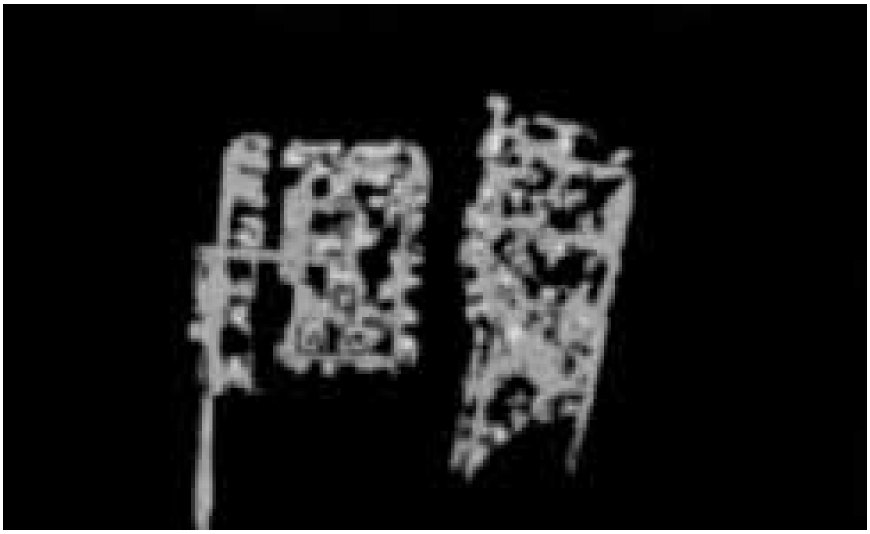


Figure 6. After filtering (A P Suherman P, 2014)

In the GPS control points, placed prism and scanning, which prism P14 installed at the control point (NRP_1), the prism P1 at the control point (NRP_2) and the prism P29 at the control point (NRP_3), in order to obtain geo-referenced models, such as shown in the Figure 7.

Building height is measured from the model geo-referenced as the Figure 8.

Furthermore, the modeling is done using software Geomagic, AutoCAD, and Google Sketch Up, 3D solid model is obtained as shown in the Figure 9.

Conclusion

- Mapping 3D parcels can be done with a laser technology equipment as TLS and building height is measured from the model geo-referenced

- In 3D cadastre, requiring detailed shape of the building, so it should be no permission for the scanning from the owners of the parcels.

- The 3D solid model, can support the management of coastal areas of Government of DKI Jakarta.

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Table 2. Elevation of GPS Control Points (A P Suherman P, 2014)

ID	Ellipsoid Elevation h (m)	Undulation N(m)	Orthometric Elevation/ H (m)
NRP_1	18.8313	18.6911	0.1402
NRP_2	18.7949	18.6928	0.1021
NRP_3	18.4291	18.7072	- 0.2781

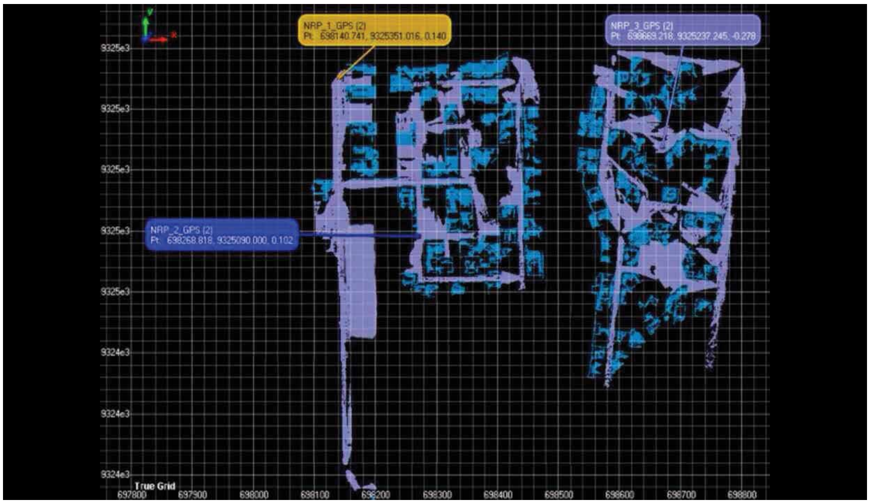

Figure 7. Geo-reference model (A P Suherman P, 2014)

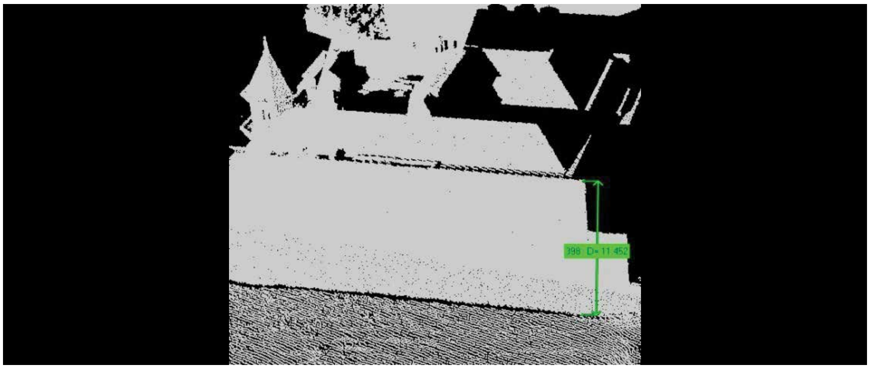

Figure 8. Building height on the model (A P Suherman P, 2014)

Figure 9. 3D Solid Model (A P Suherman P, 2014)

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Munich Satellite Navigation Summit 2018

GNSS will play a key role for autonomous systems in the future – whether it is on the road, in the air or at sea.

The renowned conference "Munich Satellite Navigation Summit" was held on March 5 - 7, 2018, again organized by the Institute of Space Technology and Space Applications (ISTA) of the Bundeswehr University Munich. High-ranking speakers from all over the world met at the Old Bavarian State Bank in Munich to talk about the role of GNSS for future autonomy.

The Munich Satellite Navigation Summit took place for the 15th time and is every year organized in cooperation with the Bavarian Ministry for Economy and the Media, Energy and Technology. The internationally recognized conference with its political focus is unique and attracted about 450 participants from 29 nations.

Opening speakers from left to right: Matthias Petschke, Prof. Bernd Eissfeller, Prof. Dr. Johann-Dietrich Woerner, Graham Turnock, Harold Martin, Prof. Thomas Pany, Oleg Kem, Jun Shen, Go Takizawa, Carlo des Dorides, Simon Plum

Competition and cooperation in Satellite Navigation: Who wins?

The three-day conference was kicked off on March 5. Prof. Bernd Eissfeller officially passed over the leadership for the Summit to Prof. Thomas Pany, who took over the professorship for satellite navigation in December 2016. With a crystal ball as a symbol for the handover of responsibilities, Prof. Eissfeller gave his best wishes for the future of the conference. Ilse Aigner, the Deputy Bavarian Minister-President and Bavarian State Minister for Economic Affairs and the Media, Energy and Technology, emphasized that the work in the field of satellite navigation is ground-breaking and that the technological progress has an impact on our daily life. Henceforward, she pointed out that the dialogue between citizens, researchers, engineers and politicians of different origins is vital to move forward.

The podium of the opening featured again prominent guests like Prof. Dr. Johann-Dietrich Wörner, Director General of the European Space Agency, or Matthias Petschke, Director of the EU Satellite Navigation Prorgrammes at the European Commission. Together with further top-class representatives of governments and institutions from Europe, the USA, China and Japan they answered questions from the moderator Claus Kruesken, a renowned Bavarian radio moderator. According to the overall topic of the discussion "Competition and Cooperation in Satellite Navigation – Who wins", the panellists spoke about current collaborations as well as the competition amongst the systems. All representatives agreed that in the end the user of the technology has to be the winner.

Prof. Dr. Wörner highlighted the competition as a motor of innovation. Harold Martin, Director of the National Coordination Office for Space-Based Positioning, Navigation, and Timing in Washington DC, USA endorsed that competition is necessary in order to improve the service for the user constantly. He emphasized the fact that all GNSS are improving and this leads eventually to a continuous improvement of the Global Positioning System (GPS). Harold Martin further pointed out that with the Internet of Things, UAVs and autonomous systems the society finds itself in the "Golden Age of Satellite Navigation". In the end of the panel discussion it was clear that a good cooperation beyond national borders is necessary to provide reliable signals and to improve the accuracy.

Program Highlights – Focus on autonomy

The following two conference days offered the participants a versatile program that was – according to the overall topic “GNSS – the key to autonomy?” – dedicated to the future of autonomous systems and the related role of satellite navigation. In a panel discussion on the requirements of autonomous vehicles several representatives from research institutions and companies got a word. The speakers showed that the position determination with GNSS became a safety-critical application in the framework of autonomous driving.

The chairman of the session, Jari Syrjärinne from HERE Technologies, summarized that the offer of GNSS services is not yet fully synchronized with the requirements of autonomous vehicles. He mentioned that besides the high-precision positioning it is also necessary to ensure the reliability in urban areas. To achieve a high accuracy and reliability, GNSS signals need to be combined with other sensors. Another session on the future of precise point positioning for autonomous systems was chaired by Dr. Herbert Landau, Managing Director at Trimble Terrasat GmbH. One of his panellists, Curtis Hay from General Motors, showed with his presentation that GNSS is essential for cars starting to drive autonomously in 2018 on U.S. highways. Dr. Ignacio Fernández-Hernández, Galileo Commercial Service Manager at the European Commission, announced that Galileo will provide a free-of-charge high-accuracy-service (HAS) in 2020 for similar purposes, which led to intense discussions.Another panel discussion took up the questions on different legal regulations, chaired by Dr. Ingo Baumann and Dr. Oliver Heinrich from BHO Legal. Dr. Heinrich explained that the variety of involved technical components leads to an extensive data collection. On that account, it will also be important to take a closer look at data protection in the future.

After numerous interesting round table discussions it became clear that GNSS will play a key role for autonomous systems in the future – whether it is on the road, in the air or at sea.

Besides the technical program, 14 companies and institutions like Airbus Defence and Space, the European Commission or NavCert GmbH presented current activities, products and research results at the international exhibition.

Munich Satellite Navigation Summit 2019

The Munich Satellite Navigation Summit 2019 will take place on March 25 - 28, 2019. Up-to-date information on the conference can be found at *www.munich-satellite-navigation-summit.org*.

Kristina Kudlich
kristina.kudlich@munich-satellite-navigation-summit.org

India and France agree to enhance cooperation in space technology

India and France issued a Joint Vision for Space Cooperation, during the recent visit of French President, Mr Emmanuel Macron, to India.

The vision lists specific areas for future cooperation between the Indian and French space agencies, ISRO (Indian Space Research Organistion) and CNES (Centre national d'études spatiales), and build on the historical linkages between India and France in the area of civilian space. The Indo-French relationship in space is spread over different facets of space science, technology and applications, including sounding rocket development, liquid engine development, hosting of payloads, joint satellite realization, training programmes, satellite communication experiments and satellite launches. The cooperation initiatives outlined below will be executed through suitable existing or new joint mechanisms, including with inter-agency representations, led by ISRO and CNES.

To realise the societal benefits of space technology, both sides will cooperate in remote sensing of earth using satellites. This includes: 1) joint development of advanced instruments and joint missions to study weather and climate; 2) sharing of data including direct reception from each other's Earth observation missions meant for Meteorology, Oceanography, Resource inventory and Cartography; and 3) sharing of expertise in data analysis including algorithm development and modelling to derive useful information for the benefit of humanity.

The partnership will be extended to the area of high resolution earth observation leading up to a joint earth observation mission with high resolution imaging capability in optical and microwave domains. ISRO and CNES will share expertise on satellite navigation, notably on system performance assessment by independent means (for instance through reference stations in France and India to improve satellites' orbit determination and clock estimation for the Indian and European navigational systems); and navigation applications. *www.opengovasia.com/*

EC and DOS of India signed landmark co-op arrangement to share EOS data

To allow the benefits of the European Union's Copernicus Earth Observation and Monitoring programme and of the Indian fleet of remote sensing satellites to extend beyond the borders of the partners, in Bangalore, on 19 March, the European Commission (EC) and India's Department of Space (DOS) signed a landmark Cooperation Arrangement related to sharing of Earth observation satellite (EOS) dataThe Copernicus programme provides a wide range of applications, e.g. climate change, land, ocean and atmosphere monitoring as well as support in the forecasting, management and mitigation of natural disasters. Its full, free and open data policy has proven its merits by allowing the development of a thriving user base in Europe and beyond. On the other hand, India has developed an ambitious and wide-ranging Earth Observation programme, which is managed by the DOS of India and implemented by the Indian Space Research Organisation (ISRO).

Under this arrangement, the European Commission intends to provide India with free, full and open access to the data from the Copernicus Sentinel family of satellites using high bandwidth connections from data hub to data hub. Reciprocally the Indian DOS will provide the Copernicus programme and its participating states with a free, full and open access to the data from ISRO's Earth observation satellites including historical data sets. It is intended that ISRO's satellite data will be made available for distribution on the European 'Copernicus hub'. This comprises land, ocean and atmospheric series of ISRO's civilian satellites (Oceansat-2, Megha-Tropiques, Scatsat-1, SARAL, INSAT-3D, INSAT-3DR) with the exception of commercial high-resolution satellites data. The Cooperation Arrangement includes technical assistance for the establishment of high bandwidth connections with Indian Space Research Organisation (ISRO) sites, in particular through setting up of mirror servers, data storage and archival facilities.

Considering the importance of in situ observations, which are complementary to space-based observations, the Indian DOS will facilitate access to in situ data from its regional observatory networks of geophysical and meteorological data, to support the enhancement of the Copernicus data architecture and towards development of global products. ISRO will co-ordinate access to in situ data and promote the use of information and data provided by the Copernicus programme with various institutions and government agencies, particularly the environmental sector and all other users, including academia and the private sector. This Cooperation Arrangement is also expected to lead to the development of an active downstream sector in the European Union and in India, as well as to joint product development. They aim at facilitating the involvement of diverse users in the development of products and services.

In particular, both sides intend to encourage cooperation on data processing for common use in line with the EU-India Agenda for Action-2020, e.g. long-term management of natural resources, monitoring of marine and coastal areas, water resource management, impacts of climate variability and climate change adaptation, disaster risk reduction, food security and rural development, infrastructure for territorial development and health management issues. The Cooperation Arrangement has been signed in Bangalore on 19 March by Mr Philippe Brunet, Director for Space Policy, Copernicus and Defence, on behalf of the European Commission and by Dr PG Diwakar, Scientific Secretary, ISRO on behalf of the Department of Space of India. *https://eeas.europa.eu*

After 'incomplete' CZMP, IRS told to add details of fisherfolk

Almost a month after publishing the draft State Coastal Zone Management Plan (CZMP), the Department of Environment has asked the Institute of Remote Sensing (IRS) to carry out micro-level coastal mapping to identify fishermen assets, a detail that should have been in CZMP before being published for public comments.

In a series of orders, the National Green Tribunal has categorically said, States are duty bound to strictly adhere to Coastal Regulation Zone (CRZ) Notification, 2011 while preparing CZMPs. However, the State's draft management plan, prepared by the National Centre for Sustainable Coastal Management (NCSCM), lacks critical information mandated by the notification to protect the coast from unscientific exploitation, it is pointed out.

For instance, while classifying CRZ areas under hazard mapping, the States should identify the fishing villages, common property of fishermen communities, fishing jetties, ice plants, fish drying platforms or infrastructure facilities of fishing and local communities such as dispensaries, roads, schools, and the like. They should be indicated on the cadastral scale maps. States also should prepare detailed plans for long-term housing needs of coastal fisher communities in view of expansion and other needs, besides disaster preparedness.

According to sources in IRS, a MoU has been signed with environment department to conduct micro-level 1:4000 scale mapping to identify fishermen assets. *www.newindianexpress.com*

China launches latest land surveying satellite into space

On March 17, 2018, China marked its eighth orbital launch of 2018 to send the fourth Land Surveying Satellite into space. Given that the task of the mission was to deliver the satellite into a low-Earth orbit (LEO), the flight most likely lasted for about 10 minutes.

Land Surveying Satellite-4 (also known as LKW-4, Ludikancha Weixing-4 or Yaogan Weixing-34) was built by the China Academy of Space Technology (CAST). It is believed to be an electro-optical observation satellite based on the military Jianbing-6 series. The spacecraft most likely utilizes uses the CAST-2000 bus, which has a dry mass of about one metric ton. *www.spaceflightinsider.com*

Remote sensing centre for fodder crop estimation in Gujarat

In a bid to provide milk producers information on fodder cultivation and production estimates, Amul has set up a satellite remote sensing centre in Anand, Gujarat in India, which would cover Kaira, Anand and Mahisagar districts. Initially, five districts of Central and North Gujarat will be covered for fodder crop estimation.

In 2017, the Gujarat Cooperative Milk Marketing Federation (GCMMF) and ISRO had signed a memorandum of understanding (MOU) to this effect.

The centre would help milk producers know when to initiate cultivation of fodder crop by using satellite images. The first remote sensing centre for estimation of fodder crops in Kaira and Anand districts was opened at Amul Dairy in Anand recently. It would gradually be scaled up to all the districts of Gujarat through the respective milk unions of the GCMMF. This is an innovative way to help milk producers know when to initiate cultivation of fodder crop by use of satellite images.

It would help farmers estimate fodder production, plan to grow/ intensify production and improve availability, leading to increase in milk production and economic benefit. This would pave a new era in fodder crop management using satellite data, Amul said in a statement.*www.thehindubusinessline.com*

Frankincense tree research in Oman using RS

Sultan Qaboos University (SQU) and University of Nizwa (UON) have come together to use the GIS and remote sensing techniques to study frankincense trees in select areas of the Dhofar region. It is difficult to study frankincense trees because they are widespread and many of them are located at a high altitude on mountains and hills.

By using GIS and remote sensing techniques, however, one can overcome this problem of inaccessibility by using imagery to study the species. Work on the study titled "Mapping and change detection study of frankincense tree (Boswellia sacra) using GIS database and remote sensing techniques in Huluf, Wadi Sahnut, and Wadi Dawkah in Dhofar" is likely to get underway within this month. *http://timesofoman.com*

Copernicus Data Warehouse offers 40 cm imagery

On March 16, the European Space Agency released an updated version of the Copernicus Data Access Portfolio offering 40 cm imagery from the WorldView-3, WorldView-2, and GeoEye-1 satellite missions. This is the highest resolution imagery ever offered to Copernicus users who are eligible to order rush image tasking through the service. These users include the Copernicus Emergency Management Service and the European organisations operating the Copernicus Security Service: FRONTEX, the European Union Satellite Centre, and the European Maritime Safety Agency (EMSA). The 40 cm resolution data is available for both standard orders and time-critical rush orders. On average, imagery ordered from the archive in the rush mode takes less than 2 hours to be delivered, and new image collections less than 3 hours, enabling agencies to respond to critical situations in a timely manner. *www.euspaceimaging.com*

Greece launches its own space agency

Greece launched its first space agency as an effort to rebuild the ailing economy as it exits a severe eight-year debt crisis. Entering into the space sector can make Greece stronger and more productive, increasing the country's standing in many ways. Greece has been a member of ESA since 2005 and has invested millions of euros in ESA's research programmes but was one of the few member states lacking a national institution. *www.bgr.in*

Galileo update

Airborne to manufacture solar array panels for Galileo satellites

Airborne Aerospace has announced on March 22 it has been awarded a contract by Airbus Defence and Space Netherlands (Airbus DS NL, Ottobrunn, Germany) to manufacture 48 substrate panels, which consist of high-performance carbon composite materials, for the solar arrays of 12 new Galileo FOC satellites.

The contract, carried out under a programme of the European Union, is the latest result of years of successful collaboration between the two Dutch companies to power the Galileo constellation. To date, Airborne delivered 88 panels to Airbus DS NL, which has also been prime contractor for the solar arrays of the 22 Galileo satellites already built. *www.compositesworld.com*

GSA, Thales launch the EDG^{2}E project

The European Union's Global Navigation Satellite Systems Agency (GSA) has officially launched the EDG^{2}E project (Equipment for Dual frequency Galileo GPS and EGNOS) with a consortium led by Thales.

This four-year project intends to develop a dual-frequency multi-constellation receiver, enabling enhanced navigation capabilities, support standardisation and certification preparation.

The consortium includes Thales, Thales Alenia Space and ATR, as well as contributions from Dassault Aviation and the French Civil Aviation Authority (DGAC).

The GNSS receiver is the cornerstone of aircraft navigation systems. The system processes signals from satellite constellations and the Space Based Augmentation System (SBAS) to accurately determine aircraft position, altitude and velocity.

The prototype receiver developed under the auspices of the EDG^{2}E project will use signals from US GPS and European Galileo positioning systems, as well as from SBAS multi-constellation EGNOS. The project aims to achieve a prototype demonstration by 2021. The prototype receiver performance will be evaluated during a flight test campaign performed by ATR using one of the company's test aircraft.

Initiated by the EC's GSA, the EDG^{2}E project will support the launch of the Galileo satellite constellation.

EGNOS has been certified for use in aviation since February 2011, and is an effective system to complement the US GPS, in order to provide better levels of performance, consequently enhancing aircraft approach capabilities. The next generation of EGNOS, called EGNOS V3, will further enhance performance by complementing both the EU Galileo and the US GPS satellite navigation constellations.

KYMCO launches Noodoe Navigation

KYMCO has launched Noodoe Navigation, a revolutionary navigation experience designed from the ground up for riders. It pioneers a ROAD-FOCUSED NAVIGATION concept.

It is a completely new rider-centric approach in the navigation industry. Instead of continuously telling riders how many meters until the next turn- and requiring them to stare at the screen repeatedly- Noodoe Navigation presents the number of intersections on the side of the street before your next turn. As a result, riders simply count down the streets without the need to repeatedly look down, allowing them to stay focused on the road as they approach the next maneuver. During the entire ride, there are no unwanted alerts or interruptions. Riders can confirm the approach of the next turn whenever they want. *http://markets.businessinsider.com*

HP Introduces workstation for Machine Learning Development

HP has unveiled a set of industry-leading machine learning (ML) solutions, including the HP Z8, the world's most powerful workstation for ML development1. HP Z Workstations, with new NVIDIA technology, are ideal for local processing at the edge of the network – giving developers more control, better performance and added security over cloud-based solutions. The use of workstations for machine learning development is the gateway to automating workflows in areas such as facial identification, sentiment analysis, fraud detection and predictive analytics.

As machine learning algorithms advance and data sets grow, the platform of choice for ML development is local processing at the edge of the network.

Waymo and Jaguar Land Rover announce long-term partnership

Jaguar Land Rover and Waymo have announced a long-term strategic partnership. Together, the two companies will develop the world's first premium self-driving electric vehicle for Waymo's driverless transportation service. Jaguar Land Rover and Waymo (formerly Google self-driving car project) will work together to design and engineer self-driving Jaguar I-PACE vehicles. This long-term strategic collaboration will further Waymo and Jaguar Land Rover's shared goals: to make cars safer, free up people's valuable time and improve mobility for everyone.

To date, Waymo is the only company with a fleet of fully self-driving cars — with no one in the front seat — on public roads. Later this year Waymo will launch the world's first self-driving transportation service allowing members of the public to use Waymo's app to request a vehicle. *https://media.jaguarlandrover.com*

GM to begin mass production of autonomous cars by 2019

General Motors will begin mass scale autonomous vehicle production at Michigan's Orion Township plant in 2019. From the last few years, the company has been pouring investment into autonomous vehicles and has absorbed Cruise Automation, a San Francisco-based start-up. The Cruise AV will have a dedicated assembly line at the plant, where the LiDAR modules, built at the Brownstown plant, will be integrated. GM has approved of $100 million in improvements to both locations.

Baidu tests autonomous cars

Chinese internet search giant Baidu Inc obtained a license to test its self-driving cars on open roads in Beijing recently. The company became the first enterprise to conduct road tests in designated zones in the capital. Five vehicles using Baidu's autonomous driving system Apollo underwent an open road test in Yizhuang, a southern suburb in Beijing.

The municipal government issued the country's first guideline for road tests of autonomous vehicles in December. To qualify for road testing, a vehicle must already have been test-driven for at least 5,000 kilometers in a closed environment and the backup drivers should have received no less than 50 hours of training, according to the Beijing Commission of Transportation The commission said the city's first closed test center was opened in Haidian district. The test site covers about 13.3 hectares, allowing vehicles to be tested under as many as 100 road conditions, such as those found on urban and rural roads.

China expects vehicles with some autonomous functions to account for half of new vehicles sold in the country by 2020, according to a guideline released by the National Development and Reform Commission in January. *http://usa.chinadaily.com.*

California will let autonomous cars operate

Waymo has already been testing cars without contingency drivers in Arizona The California Department of Motor Vehicles announced rule changes recently that would allow auto companies to test completely driverless cars on public roads beginning in April. Whereas the state previously required a person to sit behind the wheel in case the autonomous vehicle needed course correction, these cars now only have to have oversight from a remote operator and be capable of communicating with law enforcement and passengers in case anything goes haywire.

As of now, 50 companies are testing almost 300 licensed self-driving cars in the state. Industry experts believe these new, more flexible rules will accelerate the development of a budding self-driving car industry that's largely based in California. Waymo and Uber have tussled with the state's regulators in the past over what the manufacturers saw as draconian protocols, so they had been conducting much of their testing in Arizona where there are no regulations for autonomous vehicles. Waymo began operating cars without any contingency drivers in Phoenix last year.The DMV's latest move still doesn't quite create this devil-may-care regulatory climate in California, though the rule changes do bring the state more in line with Florida, where self-driving cars also only require a remote operator h*ttps://slate.com*

Ford partners with Domino's and Postmates on self-driving car project

Ford has declared a new self-driving vehicle project that will see the company joining hands with Domino's Pizza DPZ and delivery service Postmates in Miami, Florida. The automobile giant has further expanded its partnership with Argo AI to start mapping roads throughout Miami-Dade County using a fleet of Fusion Hybrids. Ford referred to the area's heavy traffic congestion and pointed that racking up these mapping trips could prove crucial in the eventual roll-out of self-driving cars.

Toyota to invest $2.8 billion in self-driving car project

Japanese automaker Toyota is planning to invest 300 billion yen ($2.8 billion) with two of its suppliers to form a new company dedicated to the research and development of self-driving vehicles The main objective of this development is to develop "production-quality software" for automated driving.

BMW partners with DRL to develop world's fastest drone

To break its last year's record of the world's fastest drone, the Drone Racing League (DRL) is working with BMW. The automobile company will loan its technical expertise and wind tunnel at its Aerodynamic Test Center to help the league break the 165.2 mph Guinness world speed record it set with its DRL RacerX drone. BMW is also bringing a DRL race to its BMW Welt exhibition center and museum in Munich, Germany.

The Drone Racing League has grown rapidly, thanks to a deal with ESPN and new, more spectator- and competitor-friendly DRL Racer 3. The new model, used by all pilots to ensure races are strictly a test of pilot skill, is more crash resistant and easier for spectators to follow.

senseFly's eMotion 3.5

senseFly has released eMotion 3.5, which includes a raft of new features and functionality, all designed to make the working lives, and workflows, of geospatial professionals simpler and more efficient.

eMotion 3.5 has added Beta-level language support for Simplified Chinese and Spanish,Agisoft PhotoScan integration, Smart mission resume and Live air traffic data. It now supports uAvionix's PingUSB ADS-B*/ UAT receiver, allowing senseFly operators to view live air traffic data during their missions: simply launch it, connect your uAvionix PingUSB (available for purchase from senseFly) to your ground station PC, and click eMotion's Air Traffic icon.

Drones deliver accurate 3D aerial surveys

Perth-based inspections and asset visualisation company Airscope is working with Intel to capture high resolution aerial data and create digital 3D models of Santos' Moomba oil and gas processing plant in South Australia.

An Intel Falcon 8+ drone is used to fly pre-programmed flight plans and capture several hundred aerial images on each flight. These images are then collated and stitched together to form a holistic 3D model. The image capture is sufficiently accurate to enable it to incorporate laser scanning data into the collated images to make the model accurate enough for use in detailed engineering design of major infrastructure projects.

FLIR provides thermal imaging for DJI Zenmuse XT2

FLIR Systems has announced that DJI will integrate a FLIR thermal imaging sensor technology into its new DJI Zenmuse XT2 drone camera. The DJI Zenmuse XT2, DJI's first dual-sensor and its most advanced gimbal-stabilized camera for commercial drone applications, furthers the collaboration between FLIR® and DJI. It also joins the 'Thermal by FLIR' partner program, which FLIR created to fuel thermal innovation and allow partners to leverage the leadership, quality, and innovation that FLIR's brand represents in the thermal imaging space. *www.dji.com*

Development of The Condor – 400Lbs Cargo Delivery Drone

Drone Delivery Canada has commenced development of its newest cargo delivery drone, 'The Condor' with a lifting capability estimated at 400 pounds of payload. It is being engineered to provide payload capacities of up to 400lbs and designed to fly approximately 150km. The Condor boasts a considerably larger payload compartment compared to both the Raven and Sparrow. The Sparrow obtained its Declaration of Compliance accepted by Transport Canada in December 2017. The Condor looks to accept pallet size payload shipments, ideal for transporting bulk cargo, both in Canada and abroad. *www.dronedeliverycanada.com*

Dedrone introduces drone and pilot localization technology

Dedrone has released the sensor, RF-300, which automatically locates drones and their pilots. When combined with the broad coverage and early warning capabilities of Dedrone's RF-100, the new RF-300 adds situational awareness for organizations to determine the nature and severity of threats from unauthorized drones.

The ultimate protection a facility can take against drone threats is to stop the pilot before they can cause any harm, and hold them accountable for damages. The Dedrone RF-300 provides this opportunity to enable law enforcement and site security leaders to locate and take action against trespassing pilots.

Pix4D announces Pix4Dfields

The idea behind Pix4Dfields comes from two observations: the need to produce accurate, repeatable measurements of crop health and the need to produce results efficiently and rapidly in the field, while performing more detailed analysis in the office. Both of these factors are essential to support decision making of the farmer, agronomist or the breeder. It is currently available as a closed beta, which we are opening to select users to test it and give us feedback. *https://pix4d.com*

Thales signs agreement with NASA for unmanned systems control technologies

Thales has announced that it has reached formal agreement with the National Aeronautics and Space Administration (NASA) for a Space Act Agreement to support their unmanned aircraft systems (UAS) traffic management (UTM) activity. This framework agreement allows Thales to engage with NASA on a technical and program level to continue to establish UTM in the United States, and allows Thales to leverage its global expertise in UTM. Thales will support NASA's goal to develop a UTM concept that can be transferred to the FAA in 2019 for deployment in the national airspace system (NAS). Under this agreement, Thales will collaborate with NASA for the research, development, testing and evaluation of low-altitude airspace control of UAS operating at or below 400 feet. *www.thalesgroup.com*

UK introduces new standards for drones

The standards, set to come into force for the first time in Spring 2018, will release the true potential of this industry, and transform business sectors from transport to infrastructure and agriculture to medicine, according to the group. The new measures are expected to lead to strengthened public confidence in safety, security and compliance within an industry, which is set to be one of the fastest growth sectors in the world.

According to Robert Garbett, in his role as Chairman of the BSI Committee on Drone Standards, "after several years of work and global collaboration, detailed draft standards are expected to reach BSI Committee stage by Spring 2018, following which there will be a period of wider consultation, expected then to lead to adoption shortly thereafter."

He added, "The development and adoption of the first quality and safety standards for the drone industry will make 2018 a pivotal year for an industry which is set to become a global phenomenon. It is the year when British and world standards will be crystallised, energising the industry, and enabling it to meet its full potential to the benefit of UK plc, and indeed economies worldwide."

"Two years ago drones were forecast to spawn a $100 billion industry by 2020. But today the opportunities are perceived to be even greater than this since such projections were based upon available data at that time which predominantly focused on the air industry, and we define the entire drone industry as covering surface, underwater, air, and space. If you look at the entire picture the figures are much larger and growing faster than anyone expected. If you then forecast the impact of integrating drone technologies across these environments, the figures will take on an ever more exciting dimension." *www.powerengineeringint.com*

Drone-based measurement system for navigational aid inspection

Following a joint-development effort with FCS Flight Calibration Services GmbH, LS telecom's Colibrex announces the launch of NavAidDrone, a drone-based system for navigational aid (NAVAID) inspections.

The NavAidDrone is used for field measurements required for commissioning and regular maintenance of Instrument Landing Systems (ILS). It will support Air Navigation Service Providers, NAVAID system manufacturers, and CNS (communication, navigation, surveillance) installation and maintenance service engineers. The system can also perform VOR and GBAS measurements with additional software included.

Measurement data, processed by the NavAidDrone, will now be available for areas that cannot be accessed by vehicles or conventional telescopic masts and for which measurement was therefore previously not possible.

World's First Wide-Area Security verification experiment

NEDO (The New Energy and Industrial Technology Development Organization), KDDI (a Japanese telecommunications operator), Terra Drone (a Japanese industrial drone service provider), SECOM(a Japanese security company) succeeded in the world's first security verification experiments of multiple drones using 4G LTE mobile communication network at a wide-area facility.

In this demonstration experiment, remote patrol security by four autonomous flying drones was conducted utilizing KDDI's "Smart Drones Platform." With remote patrol security flying multiple drones, it leads to security enhancement such as the discovery of suspicious individuals and fire, alerting attention, night security and so on.

Many effects are expected for remote patrol security utilizing multiple drones. Specifically, by remotely monitoring camera images installed in the drone from the operation control room, it is possible to respond promptly, such as finding suspicious individuals. Also, by combining multiple drones with different missions, wide-area surveillance will be improved, and security of large facilities will be further reinforced.

Cepton announces next-generation LiDAR solution

Cepton Technologies unveiled its Vista LiDAR product at the annual NVIDIA GPU Technology Conference. The 120-line scanner delivers 200-meters of range and 0.2 degrees of spatial resolution, and is available immediately for the autonomous vehicle market. The Vista LiDAR is significantly smaller than most solutions on the market and uses less than 10 watts of power. The sensor is the fourth LiDAR product developed by Cepton over its first 20 months in operation.

BCF support and GIS integration added to new 3D Repo version

3D Repo has released a new version of its cloud-based BIM platform that allows users to simultaneously access, via the web, the latest 3D construction models, detect changes, collaborate on them and make informed decisions. The latest version of 3D Repo includes support for the most recent open standard Building Collaboration Format (BCF) to improve BIM workflow communication; as well as live GIS data integration offering real-world project context. *http://3drepo.org*

Real-time Mapping and Visualization in CARIS Onboard 2.0

Teledyne CARIS™ has released CARIS Onboard™ 2.0. It enables users to apply processes automatically to their data in near real-time, resulting in minimized data conversion and processing times.

By making the processed products available at the office or on a survey vessel during survey operations, CARIS Onboard helps improve survey efficiency by valuably reducing the turn-around time and helping to ensure that data quality and coverage requirements are met before leaving an area. Focused around the latest web map technology, the redesigned control centre dynamically controls and monitors the automated system. *www.teledynecaris.com*

Gurugram first to get GIS mapping

Gurugram has become the first city in North India to get GIS mapping done. This would not only become the base for water, sewerage, power and roads services, but also help in putting a check on criminal activities and unauthorised construction in the city. V Umashakar, CEO, Gurugram Metropolitan Development Authority, recently said One Map Gurugram was being prepared by GMDA through taking satellite imagery to create a common infrastructure for government departments. He said resolution of 50 cm was being received through satellite imagery and after validation from drone mapping five cm resolution imagery would be received. *www.tribuneindia.com*

Discover more with new Ordnance Survey GPS Devices

Ordnance Survey (OS) has announced the launch of four new off-road OS GPS navigation devices for walking, hiking and off-road cycling. The innovative GPS units are a first for OS, and have been designed for ease-of-use straight out of the box. They boast the trusted accuracy that you would expect from Ordnance Survey, combined with advanced performance features. Covering the areas you choose, each device comes with up to 12 tiles of OS's world-famous leisure mapping, giving access to up to 8,000 km2 of continually updated maps in either 1:50,000 or 1:25,000 scale. *www.os.uk/gps*

Method to stop cyber attacks on GPS-enabled devices

A new study by researchers Nikolaos Gatsis, David Akopian and Ahmad F. Taha and their graduate student Ali Khalajmehrabadi from the UTSA Department of Electrical and Computer Engineering describes a computer algorithm that mitigates the effects of spoofed GPS attacks on electrical grids and other GPS-reliant technologies. This new algorithm has the potential to help cybersecurity professionals to better detect and prevent cyber attacks in real time.

The U.S. electrical power grid, for example, depends on GPS to give time stamps for its measurements at stations across the country. Although reliable, researchers in laboratories across the world have shown that the system can be vulnerable to spoofing cyber-attacks that can disrupt the system's time and location data.

The trio's algorithm, which can be applied to cell phones or computers as easily as a new app, has the ability to recognize false GPS signals and counter an attack while it occurs. Their main focus has been preventing attacks on the American electrical power grid, but the algorithm is applicable to several different devices. */www.utsa.edu*

U.S. Air Force awards GPS III launch services contract

The U.S. Air Force has awarded a GPS III satellite launch contract to SpaceX. This is the third GPS III launch contract awarded; the previous two also were awarded to SpaceX.

The launch contract provides the government with a total launch solution for the GPS III mission, including launch vehicle production, mission integration, launch operations and spaceflight certification. The launches will take place from Cape Canaveral Air Force Station or Kennedy Space Center, Florida. The GPS III missions are planned to launch between late 2019 and 2020. SpaceX won two previous GPS III launch contracts, one awarded in March 2017 and one in April 2016.

Iridium terminals authorized by FCC

The Federal Communications Commission (FCC) has refused to take action on concerns expressed by the GPS community, approving an Iridium request to modify its earth station licenses to take advantage of the advanced capabilities of its second-generation constellation.

The company is in the process of launching Iridium NEXT, a cross-linked network of 66 new spacecraft offering higher speeds and bandwidth for marine, aviation and land-mobile (handset/voice) operations as well as connectivity for global mobile networks, asset tracking and the Internet of Things (IoT).

Iridium's Low Earth Orbit satellites offer lower latency than geostationary telecommunications satellites. The new services will be available through Iridium's new Certus service platform and should eventually provide data and telecommunication speeds of 1.4 megabits per second, the company said.

To tap its new satellite's advances Iridium sought FCC permission in 2017 to operate a new generation of user terminals — a request that was treated cautiously by the GPS community.

The GPS Innovation Alliance (GPSIA) filed comments expressing concern about out-of-band emissions (OOBE), asking the FCC to protect GPS/RNSS operations in the 1559-1610 MHz band by setting limitations on the operation of Certus terminals.

According to Iridium, it would comply with a -70 dBW/MHz limit for out of band emissions in the band, noted GPSIA, but that that "may not mean that GPS and RNSS receivers operating in the 1559-1610 MHz band will be protected."

China launches two more satellites for BeiDou navigation system

Following the successful launch of a pair of BeiDou satellites on Jan. 11, China has launched two more navigation satellites into medium Earth orbits.

The newly launched pair are BeiDou-3 28 and 29. The satellites are part of a third phase of Beidou deployment, which will take Beidou coverage from regional to covering the countries along the Belt and Road initiative by the end of 2018, and global by 2020.

According to a website, the satellites are using a new bus featuring a phased array antenna for navigation signals and a laser retroreflector, with a launch mass of 1,014 kg. The accuracy, stability and signal strength of the Beidou-3 satellites is improved over previous versions by developments in atomic clocks, laser communications and inter-satellite links.

GLONASS Support to Piksi Multi by Swift Navigation

Swift Navigation has announced the latest firmware upgrade to its flagship product Piksi Multi GNSS module. The firmware release also enhances Duro, the ruggedized version of the Piksi Multi receiver housed in a military-grade, weatherproof enclosure designed specifically for outdoor deployments. It provides full support for GLONASS, in addition to the GPS satellite constellation. *www.satellitetoday.com*

Fifth launch brings AireonSM Global Air Traffic Surveillance System

Aireon has announced the fifth successful launch and deployment of its space-based Automatic Dependent Surveillance-Broadcast (ADS-B) payloads, hosted by the Iridium® NEXT satellite constellation. When the Aireon payloads from the fifth launch come online, the system will have nearly global coverage with 15-minute or better update intervals. This signifies optimal timing for airlines to begin testing the capabilities of space-based ADS-B. This will assist airlines with meeting the International Civil Aviation Organization (ICAO) and European Aviation Safety Agency (EASA) regulations that require aircraft be equipped with an aircraft tracking system for those flights not tracked by air traffic control by the end of 2018. With the Aireon service and access to the space-based ADS-B data, airlines can meet this directive set by regulators and safety organizations.

FlightAware and Aireon have worked together to create GlobalBeacon, a first-of-its-kind product. GlobalBeacon combines FlightAware's data processing platform and web-interface with Aireon's space-based ADS-B data, for a cost-effective, easy to deploy solution to help meet the ICAO Global Aeronautical Distress Safety System (GADSS) standards. *www.aireon.com*

Hemisphere GNSS' Multi-GNSS Vector™ V123 & V133 Smart Antennas

Hemisphere GNSS has announced the new single-frequency, multi-GNSS Vector V123 and V133 all-in-one smart antennas with integrated Atlas L-band designed for professional and commercial marine applications. Powered by Hemisphere's Crescent® Vector technology, the new V123 and V133 are multi-GNSS compass systems using GPS, GLONASS, BeiDou, Galileo, and QZSS for simultaneous satellite tracking to offer heading, position, heave, pitch, and roll. With support for NMEA 0183 and NMEA 2000, and continuing to offer ease of installation, these Vector models continue to offer the exceptional value and performance Hemisphere is known for. The V123 and V133 thrive in Radar/ARPA, AIS, ECDIS, side-scan survey, multi- and single-beam surveys, dredging, and general navigation applications. *www.HGNSS.com*

VIAMETRIS chooses the Ellipse-D inertial navigation system by SBG Systems

VIAMETRIS , specialist of SLAM-based mobile scanning systems, completes its product range with a backpack-based scanning system called the "bMS3D-360". The company continues to rely on SBG Systems' expertise in inertial navigation by integrating the Ellipse2-D, an inertial navigation system with embedded RTK GNSS receiver.The bMS3D-360 has been designed for the most challenging environments where GNSS is not accessible (indoor) or highly perturbed (urban canyons, forest, etc.). The Ellipse2-D from SBG Systems is a very compact inertial navigation system integrating an L1/L2 GNSS receiver. This industrial-grade INS computes roll, pitch, heading as well as position thanks to the embedded Extended Kalman Filtering.

In real-time, Ellipse2-D orientation data are used to correct the equipment attitude and help the SLAM computed heading. The embedded GNSS receiver provides absolute positioning to the point cloud as well as altitude constraint. *www.viametris.com*

Raytheon's GPS Next-Generation Operational Control System

This phase focuses on increasing automation and building controls for both L1C, a civilian GPS signal aimed at increasing international access, and M-code, a military GPS signal with better anti-jam capability.

Once complete, the team will begin integration and testing to keep the program on track for full system delivery in June 2021. GPS OCX is the enhanced ground control segment of a U.S. Air Force-led effort to modernize America's GPS system. The program is implementing 100 percent of DODI 8500.2 "Defense in Depth" information assurance standards without waivers, giving it the highest level of cybersecurity protections of any DoD space system. For protection against future cyber threats, the system's open architecture allows it to integrate new capabilities and signals as they become available. *www.aerotechnews.com*

Userlane raises ¢4 million to accelerate its expansion

The Munich-based startup Userlane just raised €4 million to finance its expansion and to further develop its product. Userlane, which was founded in 2015, offers a navigation system for software that allows users to understand and operate any application without formal training.

GNSS enabled GPS trackers for motorcycles

Rewire Security has announced its GNSS enabled real-time GPS Tracker solutions for motorcycles. DB1-Lite from Rewire Security offers worldwide coverage, geo-fence zones, GNSS-enabled worldwide improved location accuracy and comes with a compact and durable design. It's designed to be an optimal GPS tracking solution for motorcycles and cars.

DB1-Lite features the latest GNSS positioning system that combines GPS, GLONASS, A-GPS (assisted GPS) and Galileo satellite systems to deliver up to 1-2 meters accuracy anywhere in the World

RIEGL announces VQ-880-G and VQ-880-GH

RIEGL has announced two laser scanning systems. The RIEGL VQ-880-G is a fully integrated airborne laser scanning system for combined hydrographic and topographic surveying.

The system is offered with integrated and factory-calibrated high-end GNSS/IMU system and camera. The design allows flexible adaptation of these components to specific application requirements. Complemented by a RIEGL data recorder, the RIEGL VQ-880-G is a complete LIDAR system to be installed on various platforms in a straightforward way.

The sister type RIEGL VQ-880-GH has been specially designed with reduced height optimized for helicopter integrations.

Both systems carry out laser range measurements for high-resolution surveying of underwater topography with a narrow, visible green laser beam, emitted from a powerful pulsed laser source. Subject to clarity, at this particular wavelength the laser beam penetrates water enabling measurement of submerged targets.

STMicroelectronics launches Multi-Band GNSS Receiver

Assisting safer autonomous driving, STMicroelectronics has introduced the world's first multi-frequency satellite-navigation receiver chipset suitable for safety-critical automotive applications and high accuracy positioning at the decimeter and centimeter-level for PPP and RTK applications.

By tracking satellites of all GNSS constellations simultaneously on at least two of the frequencies used by each system (instead of one in other products), ST's automotive-quality Teseo APP (Automotive Precise Positioning) receiver provides high-quality raw GNSS data for PPP (Precise Point Positioning) and RTK (Real Time Kinematic) algorithm, which allows accurate positioning and rapid convergence time worldwide. *https://globenewswire.com*

Joint effort between SDX and Talen-X Enables GNSS Simulation

SDX has announced a new option that enables radiated emissions testing in anechoic chambers, with support for up to 16 dual-frequency antennas. This is achieved by harnessing the power of multiple graphics processing units (GPUs) simultaneously. This new SDX update brings a host of features carefully designed to improve the setup and operation of advanced GNSS simulations in anechoic chambers. In mid-2017, Talen-X and Skydel engineers began to conceptualize a GNSS simulation system emanating from their BroadSim platform for the purpose of simulating GNSS and jamming signals in an anechoic chamber. Over the next six months, Talen-X and Skydel designed, built, tested and delivered a revolutionary new Anechoic Chamber Simulator capable of simultaneously generating multi-GNSS, jamming and spoofing signals. BroadSim Anechoic can be used to support a wide variety of operational tests.

Fugro's GNSS rig positioning chosen for Norway's Statoil

Fugro has won a long-term contract to provide GNSS-based rig positioning services to Statoil Petroleum AS. The contract includes positioning of all the Statoil operated rigs on the Norwegian continental shelf and associated Statoil vessels. Fugro's specialized satellite positioning systems, utilizing all available navigation satellites (GPS, GLONASS, Beidou and Galileo), will be permanently installed on the Statoil-operated rigs and vessels.

Trimble introduces Tekla 2018 BIM Software Solutions

Tekla Structures 2018, Tekla Structural Designer 2018 and Tekla Tedds 2018 are solutions that provide increased control and improved documentation through constructible Building Information Modeling (BIM) workflows for stakeholders in structural steel and concrete, including designers, detailers and fabricators, concrete contractors, general contractors and structural engineers.

Tekla Structures 2018 brings faster 3D modeling processes, more precise detailing, better control over changes and quicker production of drawings with less effort, in addition to workflow-related efficiency gains. The new version also supports point clouds, allowing delivery of coordinated, constructible designs that fit existing structures seamlessly. Tekla Structural Designer 2018 delivers new features and enhancements focused on structural design workflow productivity. For example, the new rigorous non-linear concrete slab design feature automates loading simulation through construction to help save engineering design time.

Tekla Tedds 2018 introduces a variety of new calculations that enable improved productivity for civil and structural engineers. The easy-to-use software offers a quality assured library of code compliant calculations that are visible for easy review and validation.

Lighthouse develops a 4 frequency band input front-end processor for GNSS

Lighthouse Technology and Consulting completed the development of a series of front-end processors "Hibiki" for software receivers, processing up to 4 frequency GNSS signals simultaneously, and will start sales from April 2018.

Japanese Quasi-Zenith Satellite System (QZSS) broadcast GNSS signals in 4 frequency bands, L1, L2, L5 and L6. Similarly, GPS and Russian GLONASS broadcast in 3 bands, European Galileo and Chinese BeiDou broadcast in 4 bands. However, many conventional front-ends process only two bands at the same time, and could not be used for highly specialized applications such as processing multiple signals with different frequencies at the same time.

Answering to such GNSS technology demands, Lighthouse has completed the development of a series of front-end processors "Hibiki". Hibiki has an unprecedented capability to process up to 4 frequency bands simultaneously. One of the multiple products will be released within its lineup.

Power Generation Projects in China Leverage Bentley

Wugachong Reservoir Project in Pu'an County of Guizhou Province (Wugachong Water Conservancy and Hydropower Co., Ltd.) is a medium-sized hydroelectric power project, which moved from 2D AutoCAD to 3D BIM using the entire set of Bentley design applications, delivering the initial 3D model in just two months. Bentley GEOPAK helped the team quickly solve a complex issue with the topography of the site, enabling it to develop a zig-zag ramp design that would have been difficult to visualize in 2D. Using ProjectWise, the team collaborated across all engineering disciplines. It also created 3D videos using Bentley LumenRT to explain the zig-zag design to their clients and to promote the organization's capabilities for other projects.

Hexagon Geospatial Launches Power Portfolio 2018

Hexagon Geospatial has announced the release of its POWER PORTFOLIO 2018. The Power Portfolio helps a wide range of customers Shape Smart Change by providing solutions that harness location data to understand real-world situations, the company said in a statement. With significant upgrades to ERDAS IMAGINE, GeoMedia, ImageStation, ERDAS APOLLO, GeoCompressor, GeoMedia Smart Client, as well as our WebGIS and Mobile solutions, Power Portfolio 2018 makes it faster and easier to identify, organize, and synthesize location data with your business information. By understanding what was and what is, you can quickly sense, decide, and act as the Earth changes.

With additions like machine learning operators and even more access to sensor and UAV data, Producer Suite 2018 makes it easy to access the latest data and view it from more perspectives so you can analyze situations and predict outcomes.

Geneq introduces SXblue Premier GNSS receiver

Geneq has launched the SXblue Premier GNSS receiver, which is available in a submetric version (GNSS) or centimetric version (real-time kinematic, RTK). The new SXblue Premier GNSS receiver is equipped with the Pacific Crest Maxwell 6 Trimble technology with BD910 (GNSS version) and BD930 (RTK version) OEM boards, delivering 220 channels to acquire and track GNSS signals from all constellations in view. It makes effective use of GPS, GLONASS, Galileo, BeiDou, QZSS and SBAS signals for outstanding highly precise positioning

Septentrio's AsteRx-U MARINE receiver

Septentrio has announced an additional version of its AsteRx-U MARINE receiver with support for the Fugro Marinestar service. By incorporating Fugro Marinestar - satellite-based positioning services that make use of GPS, Glonass, Galileo and BeiDou - the AsteRx-U MARINE can deliver sub-decimetre accuracy at any global location. Continuity of operation is guaranteed by correction transmission over nine overlapping beams. To complement the standard satellite broadcast delivery channels, internet delivery is also available using Ntrip (Networked Transport of RTCM via Internet Protocol). *www.septentrio.com*

MARK YOUR CALENDAR

May 2018

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

12th Annual Baška GNSS Conference
6 - 9 May
Baška, Croatia
www.rin.org.uk

FIG Congress 2018
6 - 11 May
Istanbul, Turkey
www.fig.net/fig2018/

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

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

CSNC 2018: 9th China Satellite Navigation Conference
23 – 25 May 2018
Harbin, China
www.beidou.org/i

June 2018

GeoSummit 2018
5 - 7 June
Bern, Switzerland
www.geosummit.ch/

SPAR 3D Expo & Conference 2018
5 - 7 June
Anaheim, California, USA
www.spar3d.com/event/

HxGN LIVE 2018
12 - 15 June
Las Vegas, USA
http://hxgnlive.com

7th International Conference on Cartography & GIS
18 - 23 June
Sozopol, Bulgaria
www.iccgis2018.cartography-gis.com

2018 BGC Geomatics
18 - 23 June
Olsztyn, Poland
http://bgc2018.systemcoffee.pl/index.php?id=1

2018 Baltic Geodetic Congress
21 - 23 June
University of Warmia and Mazury in Olsztyn, Poland
http://bgc2018.systemcoffee.pl

GEO Symposium 2018
11 - 12 June
Geneva, Switzerland
www.earthobservations.org/geoss_wp.php

July 2018

GI Forum 2018
3 - 6 July
Salzburg, Austria
www.gi-forum.org

Esri International User Conference 2018
9 - 13 July
San Diego, USA
www.esri.com/events

ESA/JRC International Summer School on GNSS 2018
16 - 27 July
Loipersdorf, Austria
www.esa-jrc-summerschool.org

September 2018

Inter Drone 2018
5 - 7 September
Las Vegas, USA
www.interdrone.com

Africa GEO
17-19 September
Johannesburg, South Africa
https://africageo.org.za

ION GNSS+ 2018
24 - 28 September
Miami, USA
www.ion.org

October 2018

Joint Geo Delft Conference

The 6th International FIG 3D Cadastre Workshop

The 3D GeoInfo Conference
1- 5 October
Delft, the Netherlands
www.tudelft.nl/geodelft2018

39th Asian Conference on Remote Sensing (ACRS 2018)
15 - 19 October
Kuala Lumpur, Malaysia
http://acrs2018.mrsa.gov

Intergeo 2018
17 - 18 October
Frankfurt, Germany
www.intergeo.de

November 2018

Trimble Dimensions 2018
05 - 07 November
Las Vegas, USA
www.trimbledimensions.com

ITSNT 2018
13 - 16 November
Toulouse, France
http://www.itsnt.fr

International Symposium on GNSS (ISGNSS 2018)
21 - 23 November
Bali, Indonesia
https://www.isgnss2018.com


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