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ABSTRACTS

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Australia

Augmenting GNSS Precise Point Positioning (PPP) for Improved Performance

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Within the last decade, GNSS PPP has generated unprecedented interest amongst the GNSS community and is being used for a number of scientific and commercial applications today. Similar to the conventional relative positioning technique, PPP could provide positioning solutions at centimetre-level precision by making use of the precise carrier phase measurements and high accuracy satellite orbits and clock corrections provided by, for example, the International GNSS Service (IGS). The PPP technique is attractive as it is computationally efficient; it eliminates the need for simultaneous observations at both the reference and rover receivers; it also eliminates the needs for the rover receiver to operate within the vicinity of the reference receiver; and it provides homogenous positioning quality within a consistent global frame anywhere in the world with a single GNSS receiver. Although PPP has definite advantages for many applications, its merits and widespread adoption are significantly limited by the long convergence time, which restricts the use of the PPP technique for many real-time GNSS applications.

This presentation provides an overview of the GNSS PPP technique with aim to address its limitation in achieving high accuracy positioning within a short observation period. Two augmentation methods for PPP will be discussed and results presented: 1) using multi-constellation multifrequency GNSS observations; and 2) a hybrid system of PPP and network-RTK technique: using externally derived ionospheric delay estimates from a dense regional GNSS reference station network to enable rapid ambiguity fixing in PPP.

Bangladesh

On the Spot identification of Flood Inundation Depth from Gridded Data using GPS enabled Smartphone Application to help people fix plinth levels of their houses

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As a flood prone country, Bangladesh is facing it every year. The low lying regions are inundated every flood season and most of the people living in this areas are being evacuated to the nearest flood shelters or embankments. People are suffering and losing their livelihoods, shelters and other properties. To lessen their misery, some initiatives like raising the plinth of their houses are going on so that, the people do not need to move from their houses during flood. But this attempt is not giving full benefit as the scientific estimation of flood inundation depth in a very specific location is not available with the local people.

UNDP Bangladesh with Ministry of Disaster Management and Relief (MoDMR) has implemented Comprehensive Disaster Management Programme (CDMP) and under this programme, they developed Flood Inundation Depth Map considering historical flood and return period. This map will be used to identify spot level Flood Inundation Depth using Smartphone.

The gridded data kept in a server will be accessed from the remote area using smartphone over Internet through nationwide GSM network. The smartphone application will capture the location information using its built-in GPS module and will send the latitude/longitude value of a particular spot (where the house will be built with plinth level having sufficient free board above flood level) to the server using its GSM module. The server then using API developed will retrieve the inundation depth at that particular location/spot/grid from gridded inundation depth information and will send it back to the smartphone.

This flood depth information can be used in other purposes, such as to fix road crest level, construction of bridges/culverts and other infrastructures development like flood shelter, school, clinic etc.

China

Update on BeiDou Navigation Satellite System (BDS)

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As a global navigation satellite system compatible with other navigation satellite systems worldwide, BeiDou Navigation Satellite System (BDS) is independently established and operated by China. This presentation introduces the BDS's policy of development, latest progress and recent plan.

The whitepaper on BDS has been released in June 2016 to interpret its development concepts and propositions. BDS provides Open Services Free of Charge, ensures safe and reliable operations, disseminates BDS information in a timely manner and protect the utilization of radio-navigation satellite frequency spectrum

BDS is steadily accelerating the construction and improve its performance. At same time, The Chinese authority attaches high importance to the application promotion of BDS. BDS has made great progress in fundamental products and also implemented several application demonstrations in the field of transportation, fishery, meteorology, intelligent city, etc. Meanwhile BDS has got recognition from the mass market both home and abroad. So BDS industrialization is thrived development. In addition, BDS commits to cooperate with other satellite navigation systems, promoting the compatibility and interoperability of multi-GNSS, so as to provide better services for global users. BDS will continuously promote the international coordination on multilateral platforms, and make efforts to enter into the international standardization, promote the popularization of satellite navigation, and facilitate the academic exchange, education and training in the navigation area.

As for recent plans, BDS will construct the global constellation, establish augmentation systems and launch the GEO satellite of BDSBAS, and continuously strengthen international cooperation.

Croatia

Software Defined GNSS Receiver as a Framework for GNSS-related Research and Education

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Software defined radio (SDR) is a recent concept in signal processing and radioengineering, that allows for more efficient and high-quality spectrum utilisation and quality of information transfer, as well as flexibility in construction of radio equipment. The specialised hardware minimisation, and expansition of signal processing in baseband and for application purposes on the general-purpose computing-oriented hardware render an SDR a powerful platform for radioengineering development. The SDR concept has been widely accepted in the satellite navigation segment, allowing for smooth transition to modernised core GNSS systems and acceptance of advanced GNSS systems and services, requiring software modifications only. Numerous research groups offer the SDR GNSS receivers for various operating systems (MS Windows, Linux/Ubuntu/Fedora, and even Google Android) as open-source software, requiring an inexpensive USB-based radio-frequency (RF) front-end for the complete GNSS operation capabilities.

Here a case is presented of deployment of an SDR GNSS receiver for research and education purposes, based on the open-source software and an inexpensive RF front-end. The research and education opportunities in utilisation of such an SDR GNSS receiver are discussed. The presentation concludes with a brief outline of MSc courses 'Software defined radio' (with emphasis on construction of and research on SDR GNSS receiver, including spectrum utilisation and monitoring, and statistical sensor fusion) and 'Applied satellite navigation' (with emphasis on signal processing, efficient spectrum utilisation and monitoring, statistical sensor fusion for SDR GNSS) taught at University of Rijeka, Croatia.

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Egyptian Permanent GPS Network (EPGN) and Geodynamic Studies using the Global Positioning System Data: A case study of Stationary Network in Egypt

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After the intermediate earthquake that occurred on November 14,1981 with magnitude of 5.6 at kalabsha area, 60 km south of the High Dam. The National Research Institute of Astronomy and Geophysics (NRIAG) started its scientific program for monitoring recent crustal movements and its relation to earthquake activity in 1984. This program has included establishing of geodetic networks, measuring and analyzing of the data collected from different geodetic networks. In 2006, NRIAG started the establishment of The Egyptian Permanent GPS Network with 4 stations only, by the first of 2016, the number of this network increased to reach about 24 stations in addition to local networks. A Global Positing System (GPS) technique as one of the Global Navigation Satellite Systems (GNSS) was applied to study the geodynamics of these areas.

In this study we attempt to introduce a horizontal velocity field of Egypt using GPS data of 130 station (13 of them are permanent stations and belonging to (EPGN) covering the period from the begining 2013 to the end of 2014. In addition to 123 permanent stations from different sources (IGS, EPN, UNA and SOP) to give good configuration around Egypt. The data were processed using Bernese software V.5.2. The ratio between formal standard deviation and the repeatability from combined solution were used to estimate scale of the covariance matrix that ended to scale error. Due to the unrealistic uncertainties of Bernese result so to handle the absence of time correlation in GNSS result, new approach were used to estimate realistic uncertainties for the time correlation in GNSS time series. This approach is CATS software was used for the time series analysis. Two stochastic models were used; these models are white noise and white noise plus power law noise. Based on its results almost the Egyptian stations are moving in North east direction with magnitude 28 .29 ± 0.7 mm / yr.

Estonia

Verification of GNSS data in Estonia

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Estonia is situated at the South-East corner of the Fennoscandian post-glacial rebound area, thus the impact of ongoing Glacial Isostatic Adjustment can be noticed on accurate geodetic measurements, such is GNSS. In this contribution we use horizontal and vertical uplift rates derived from (1) the time series of several Estonian GNSS permanent reference stations (CORS), and (2) GPS campaigns held in 1997 and 2008. From modelling, we use (1) open source software SELEN (Spada and Stocchi, 2007) to model the surface displacements and other geodetic quantities in response to the melting of ice sheets, (2) GNSS-based land uplift rate model and (3) the latest available land uplift models (NKG2015LU and EST2013LU). In most cases good fit between the observations and models was found within study area. The higher discrepancies appeared in the East and South-East Estonia.

Fiji

Positioning in the Pacific Islands

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Pacific Community (SPC)

The small islands and atolls in the Pacific are widely spread out and the Pacific Community (SPC) has been providing technical support with respect to accurate definition as per location of these islands and atolls. Most of the islands and atolls in the pacific are low lying (some are 2 to 3 metres above mean sea level), therefore it is very important to have a vertical reference system established, so that the pacific islanders are able to accurately know how high or above are their islands above sea level, whether it is chart datum or mean sea level datum. Since these islands are fairly remote and the tides are different in each location, it is very important to have an accurate vertical and horizontal reference system recognized regionally and globally and above all it is quite a challenging task.

The Geoscience for Development Programme in the Geoscience Division of SPC has been actively involved in the regional projects in the 14 project member countries such as the Pacific Sea Level Monitoring Project and Pacific Regional Maritime Boundaries project funded by the Government of Australia.

Most of the Pacific Island countries need to develop their datum from local system to international reference such as ITRF. There is no local geoid model in place except to utilize the global geoid model such as EGM2008 in this region. The Pacific Island countries are keen to establish their Geodetic Infrastructure.

With the modern techniques available, the pacific island countries would need financial assistance from aid agencies and expertise from the organizations such as UN-GGIM, FIG, IAG and ICG not only to develop their geodetic survey infrastructure (CORS/IGS Network) but also to establish their vertical and horizontal reference frame in terms of international standards and specifications. Development of geodetic survey capacity is a need in the region is also necessary.

Pacific Island countries in the region have signed up for the UN Resolution A69/L.53 on the Global Geodetic Reference Framework through UN ECOSOC policy. The innovation of Geodesy from traditional and classical/ physical to this modern geodesy still needs to be addressed in this region, the evolution of the two-dimensional to three dimensional worlds is emerging and the vertical reference is as important as the horizontal reference.

The Pacific Islands need to develop a unified reference frame either at local level or national level since the islands and atolls are fairly separated to each other and they are dynamic in nature and the effects of climate change, changes the geographical status. As I would see that datum unification in the pacific island countries will be the way to move forward.

Development of geodetic survey capacity is a need in the region, where survey professionals are aware of what and how to develop their local reference into international reference frame with the aid of modern survey technology such as applications of GPS/GNSS for Surveying and Geodesy.

Countries that have adopted the international reference frame by having several IGS stations, can be seen as examples in this region and these techniques can be adopted but pacific island still have far way to go; therefore assistance is a prerequisite.

Land Surveyors as geospatial professionals play crucial roles in expanding this sector to satisfy the demand of the industry. Opportunities to provide and interpret 3D measurements for building, terrain and infrastructure modelling are expanding faster than ever and application of GNSS will assist as a powerful mechanism for "Positioning"

The Asia Pacific Reference Frame (APREF)

John DAWSON, Geoscience Australia,
Andrick LAL, Pacific Community

The Asia-Pacific Reference Frame (APREF) Project is a regional initiative that seeks to improve the geodetic infrastructure of the Asia-Pacific region. It is a joint effort of the United Nations Global Geospatial Information Management (UN-GGIM) and the International Association of Geodesy (IAG). APREF provides a regional densification of the International Terrestrial Reference Frame (ITRF) and based on GNSS, with data currently being processed by four independent Analysis Centres (ACs). The contributions of these ACs are combined into a weekly solution by the APREF Central Bureau which are used to produce a coordinate time-series of stations together with a quality assessment of their performance. This presentation gives an overview of the current status of APREF.

France

Space Weather : From the Sun to the Earth the key role of GNSS

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T/ICT4D, Abdus Salam International Centre for Theoretical Physics

Since two decades a new scientific discipline ‘Space Weather’ based on the integration of the physical processes between the Sun and the Earth is developing. The interest of this global approach is to unify different disciplines of the past (Solar Physics, Physics of the magnetosphere, Ionospheric studies etc…) and also to connect the fundamental research to the applications in GNSS.

This paper is devoted to :

- the main solar physical processes at the origin of GNSS technical disruptions
- the main progress in the knowledge of Ionosphere made with GNSS
- the training on GNSS and Space weather, to be developed

Germany

Technology Transfer and Capability Building in GNSS for Airspace Modernization in Nepal

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Nepal has a very diverse geographical features ranging from flat plain area to the high Himalayan mountain range. The construction of roadways is still very difficult, costly and time taking. Air transportation is the essential and only means to reach far flung remote areas and its modernization has the potential to contribute to all four areas of development - human, economic, technological and sustainability. Unfortunately, civil aviation in developing countries like Nepal suffers from safety issues. The infrastructure required to maintain standard airspace management can be very expensive. The government and regulatory body operations required to provide adequate safety oversight are expensive as well. Civil aviation safety has not always been a high priority in the country with massive debt burden, basic health, poverty and education concerns to address. As a result, Nepal has failed to efficiently implement the applicable ICAO standards and is currently in the Air Safety list of the European Commission. Despite facing several constraints, Nepal's aviation sector has been growing at a healthy rate. Development of two new international airports, Gautam Budhha Airport and Pokhara Airport, is ongoing. There is a huge task for the integrated, seamless and harmonized airspace/air route and Air navigation systems in place in light of the present and future requirement. The GNSS has given an opportunity to improve the capacity and capability and thereby maximizing the use of airspace to greater flexibility to aircraft operation.

A Performance Based Navigation (PBN) roadmap centered at the use of GNSS was formulated for a short term (2010-2012), medium term (2013-2016) and long term (2017-2025) plan. The progress has been very slow, and as of now, Nepal has used GNSS only for one operation - RNP AR APCH at the Tribhuvan International Airport. One of the reasons for the slow progress is the lack of technology capability in GNSS. There is a need to develop a GNSS plan to identify capabilities that should be in place in order to meet the various requirements and perform the steps needed for implementation. A successful transition to GNSS requires a comprehensive orientation and training program aimed at all involved parties. Therefore, a good competence in the field of GNSS to create a technical and operation team necessary to support future GNSS based air navigation services should be developed.

The capability building and technology transfer is possible only through an effective cooperation and networking in the regional and global level. The success of European Commission project "Training EGNOS GNSS in Africa" to implement GNSS for improved air navigation in Sub-Saharan Africa is a good example. In the context of Nepal, a pilot project to design and implement a GNSS monitoring system to record GNSS information to continually monitor GNSS satellites in view, to determine real-time availability of GNSS and alerts during periods of availability could enable the technology transfer. The system could also be used to predict GNSS Receiver Autonomous Integrity Monitoring (RAIM) for FIR regions and airports. The recommendation (ICAO Annex 15) to install such system was also echoed in the previous assessment performed by INECO in Nepal in 2013. The GBAS feasibility study (opportunities, constraints and cost-benefit analysis), also a part of the PBN roadmap, is also envisaged as a follow up project by utilizing the GNSS reference stations. These envisaged projects and identified issues will be used as an initial step for preparation of effective cooperation and networking in the area of capability building in GNSS for airspace modernization in Nepal.

India

Initial Results of IRNSS Standalone and Hybrid Operations

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Indian Regional Satellite Navigation System (IRNSS), developed by the Indian Space Research Organization (ISRO) is designed to provide PVT services in and around India. Since end of April, 2016, all the planned 07 satellites (03 GEOs and 04 IGSOs) are in orbit transmitting signals in L and S-band those can be used for PVT solutions. Fully operational IRNSS is expected to enhance the scopes of utilizing hybrid Multi-GNSS signals from the primary and secondary service areas. Initial reports on position fix using IRNSS are available; this presentation discusses on initial results on the capabilities of IRNSS in standalone and hybrid mode of operation with GPS, and advantages of IRNSS utilizing data collected from eastern part of India.

IRNSS signals are monitored from Burdwan (23015.2755’ N, 0870 50.8071’ E) , India using two co-located GNSS receivers- an IRNSS-GPS-SBAS (IGS) receiver operating in both IRNSS L5 and S Bands and a Javad Delta G3T receiver operating in IRNSS L5 band only. Solutions in IRNSS stand-alone and hybrid mode with GPS for various combinations are obtained, and analysis of these initial data shows encouraging results in solution accuracy and satellite geometry.

Solution accuracy results improves for IRNSS standalone operations in order of S-Band, L5 band, L5+S band dual operations respectively and in all cases north errors are higher than east errors. Results on solution accuracy obtained from the data collected using two different GNSS receivers would be presented. Successful integration of IRNSS and GPS signals are observed providing better solution accuracy compared to the stand-alone IRNSS operations. The results calls for study over longer periods using GPS and individual IRNSS S and L5 signals separately, and for all-in-view operation using GPS, GLONASS and IRNSS together. For IRNSS dual-frequency operation, study is also necessary to explore the advantages of IRNSS S-band signal in mitigating interfering effects present in the GNSS L-band operation.

From satellite geometry view-point, IRNSS-only operation results in PDOP values higher than 3.0; and in cases of IRNSS-GPS hybrid all-in-view operation, PDOP values are found to be around 1.4. C/N0 values of IRNSS S-band signals are lower than those for the L5 signals. The maximum values of L5 signals are better than 50 dB-Hz and 47 dB-Hz for S-band signals and the minimum values remains around 40 and 30 dB-Hz respectively.

It has been witnessed from the same location that, for several occasions, no GPS satellite is present above 600 elevation and only 1 or 2 satellites are present above 300. Presence of GLONASS do not improve the situation much. This situation leads to relatively worse satellite geometry, and possibility of loss of GNSS solutions in degraded visibility conditions where obstructions are present at lower elevation angles. It is observed theoretically, use of IRNSS signals in hybrid operation with GPS helps to improve the situation from the Indian region. Presence of IRNSS results in larger number of usable satellites from higher elevation angles for uninterrupted solutions, and better satellite geometry in GPS-IRNSS hybrid operation. The calculated results are supported by actual observations.

The presented discussions would help in understanding the potentials and benefits of IRNSS within the IRNSS service area towards a successful and robust Multi-GNSS environment.

Acknowledgement
The authors acknowledge the support of Space Application Centre (SAC), ISRO, INDIA for providing the IGS receiver and Javad GNSS for providing IRNSS option for the GNSS receiver used in this study.

India

Solar Potential Calculation using accurate latitude with Cloud Computing

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Information of the quantity of inward solar irradiation at different co-ordinates is of vital importance in different fields such as solar potential calculation, uncertainty in prediction, rural area, electricity generation, house hold utilization, remote sensing, and environmental monitoring.

The objective of this research is to derive the mechanism to device the technology of Cloud computing and Big Data to the application area of GIS as solar potential calculation with the use of Geomatics having good prediction and less uncertainty. Also the energy utilization of the specific area and the calculation of the results based on the input parameters that, the enough solar potential is available to install the solar photovoltaic. To make enormous amounts of data that is formed by solar power making system useful and important to the potential, we apply information innovation.

Solar radiations in the form of the sunshine hours will be used as an input parameter. Sunshine hours with global horizontal irradiance (GHI) will be used to calculate the tilt irradiance on the tilted surface. Tilted irradiance will be used since it is more cost effective and efficient. Indian Meteorological Data will help in predicting the number of cloudy and rainy days for the prediction and uncertainty.

Satellite data of MODIS will be used to get the details of the aerosols and cloud properties. Simultaneous algorithms can be used to get aerosol properties over land and ocean from spectral reflectance observed by EOS-MODIS (both Terra and Aqua). These aerosols and cloud properties will be used in calculating the diffused, horizontal and reflected solar irradiance on tilted surface as well. These input parameters used together to create geographical information system data with attribute values.

Algorithms will be used as base models on the significant uncertainty in system predictors. Cloud Computing will assist in providing the power of structured and unstructured data and vast computing requirements. Models will be tested and compared based on the actual vales received after prediction and uncertainty in the values calculated.

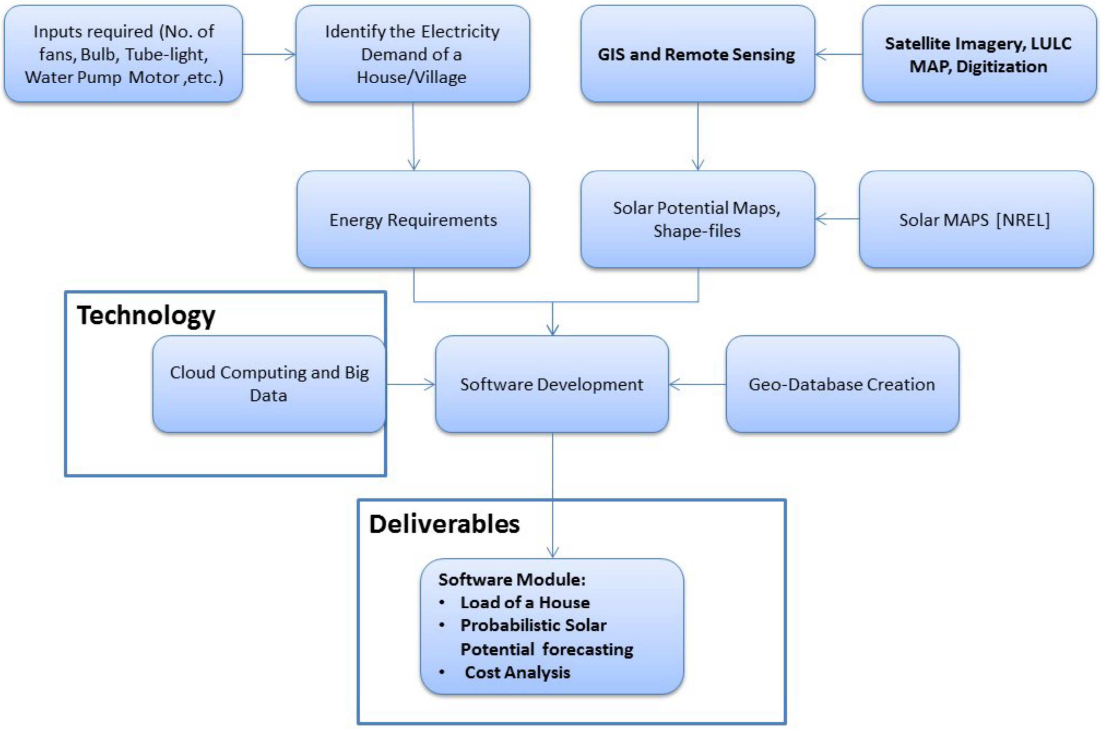

Figure1. Basic flow of the proposed research project

This research focuses on getting the accurate solar potential, Uncertainty in the calculated solar potential, estimated solar potential calculation of the area using simulated software model.

Keywords: GPS data, Solar Potential, Software, Remote Sensing, GIS, Shape-files, Energy Utilization, MODIS

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India

Multi-GNSS: experience and the benefits from India in GPS-GLONASS hybrid operation Mode

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Currently many satnav systems are in operating or in development phase and scope of using more than one system is evolving. The situation provides advantages for redundancy, system independence and more signals in space to use and is termed as Multi-GNSS. Impairments of low satellite visibility in shadow areas and atmospheric effects may be taken care of due to presence of more available signals from space. From solution accuracy point of view, such a situation presents the scope of better satellite geometry and solution accuracy for stand-alone, low-cost applications. Because of typical geographical location, users from the Indian region are expected to receive signals from more than 30 such satellites by the end of this decade but, presently we are having two fully operational (GPS and GLONASS) global satnav systems. For obtaining the benefit of multi-GNSS using all the systems together, results on the use and advantages of GPS-GLONASS operation in hybrid mode from India is discussed in this presentation as a case study.

Studying the availability of GPS and GLONASS signals from India, stable constellations are seen for GLONASS over a long time span of observation from 2010 to 2016. It may be inferred that, GLONASS can be used for position solution independently. Availabilities of both GPS and GLONASS are found to vary over time of the day. Possibility of using of same group of GLONASS satellites from places wide apart in India helps to understand the potentials of long-baseline common-mode mission planning. Average total number of satellites in GPS-GLONASS hybrid mode helps enhancing the number of usable satellites and therefore scope for optimum satellite selection improves. In many situations, like urban canyons GPS and GLONASS can complement each other to have enough number of usable satellites in the sky. Inclusion of GLONASS with GPS helps in obtaining position solution in low visibility conditions like deep foliages, urban canyons etc.

GLONASS only mode presents little more solution accuracy with respect to standalone GPS. When GLONASS is incorporated with GPS to operate in hybrid mode, along with system independence and redundancy, the instantaneous position solution improves.
In hybrid mode, operating in single frequency, i.e., GPS+GLONASS mixed operation, GLONASS shows potentials of improving the accuracy over each individual stand-alone situations. It is seen that, introduction of GLONASS along with a fixed number of GPS helps improving the solution accuracy error levels. The condition is found to be favorable when low number of used GPS (~5) is used with GLONASS but the situation doesn’t change much with higher number of GPS satellites (>6-7) used in the hybrid operation. GPS-GLONASS hybrid mode of operation helps to improve the solution accuracy with

increasing averaging time as the solutions converge fast w.r.t. individual operation. Solution accuracy is also found to be stable over a day in MIXED mode in comparison to any of the stand-alone modes. Thus users can depend more on hybrid solutions. These results related to multi-GNSS operation would be helpful for associated stakeholders of GNSS who are either engaged in developing applications and solutions or are interested in using the system.

It would be beneficial for common users to use a low cost, single frequency multi-mode receiver in hybrid mode to achieve low to medium level accuracy without the aid of any augmentation or sophisticated hardware and/or software support for cost effectiveness. Therefore, multi-GNSS would be a good solution for low cost application development. The upcoming satnav systems, when operational in near future, may be integrated together and the benefits should reach the users.

Development of The New Ionospheric Disturbance Index for GNSS User

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Using the global positioning system (GPS) measurements, the ionospheric disturbance index (W) from BAKO station (6.49°S, 106.85°E geographic), lying at southern crest region of equatorial ionospheric anomaly (EIA) have been estimated. In order to evaluate the performance of W index for GNSS user at southern crest regions in Indonesia, we have compared the BAKO W index with its receiver positions estimated using precise orbit data. For the BAKO station, the W index is found in low correlation with the GPS position error because of the ionospheric scintillation effect on GPS accuracy. This suggests that the W index is necessary to be modified for GNSS user. We propose the new ionospheric disturbance index (Wsg) as a combination of an ionospheric disturbance index and a satellite geometry that affected by the ionospheric scintillation.

Japan

Developing sustainable collaboration model for implementing integrated space-based/geospatial disaster management infrastructure to strengthen the resilience in ASEAN community

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Economic Research Institute for ASEAN and East Asia (ERIA) is an international organization established by a formal agreement among 16 heads of government at the 3rd East Asia Summit in Singapore on 21 November 2007. The University of Tokyo is now conducting the research project named “Developing sustainable collaboration model for implementing integrated space-based/geospatial disaster management infrastructure to strengthen the resilience in ASEAN community” under ERIA, and Japan Space Forum (JSF) is acting as a coordinator of this project. There are urgent needs of strengthening resilience to natural disasters in ASEAN countries. Resilience of social infrastructure has been considered an important issue for the economic development among East Asia as well as ASEAN countries. Geospatial technologies and space technologies have notable potentials to strengthen the resilience by using sustainable mechanism for integrating the technologies in practice for disaster risk management (DRM). This project aims to establish the trans-border mechanism with public-private partnership schemes.

Japan

Location-based Image Acquisition and Management for Sabo Facility Inspection

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Field-based inspection in infrastructure inspection requires some location-based applications, such as mobile interface, geo-tagged image acquisition, geolocation-based database interface, and navigation. In the current state, although 3D scanners can acquire high resolution data, it is not easy to acquire details of asset attributes with 3D measurements. Thus, we focus on ground investigation and inspection using mobile devices. In this paper, we aimed to assist investigators in infrastructure asset monitoring with location-based applications. Moreover, we propose and evaluate our location-based investigation application for Sabo facility management. Through our experiment, we explored several issues in infrastructure asset monitoring using mobile devices.

1. INTRODUCTION

Infrastructure asset management is a framework for achieving sustainable infrastructure, such as roads, bridges, railways, and water treatment facilities. In particular, the control of erosion and sediment is called Sabo. The Sabo is one of significant topics in infrastructure inspection. During infrastructure inspection, we generally refer to the latest inspection documents to determine an inspected position, as follows. First, the structure to be inspected is detected after the inspector's arrival in the inspection area. Next, an inspected point is detected in the structure. Then, the condition of the inspected point is recorded and compared with the latest inspection. After that, a geo-tagged photo is captured at the inspected point. A conventional flow for ground-based infrastructure inspection is shown in Figure 1.

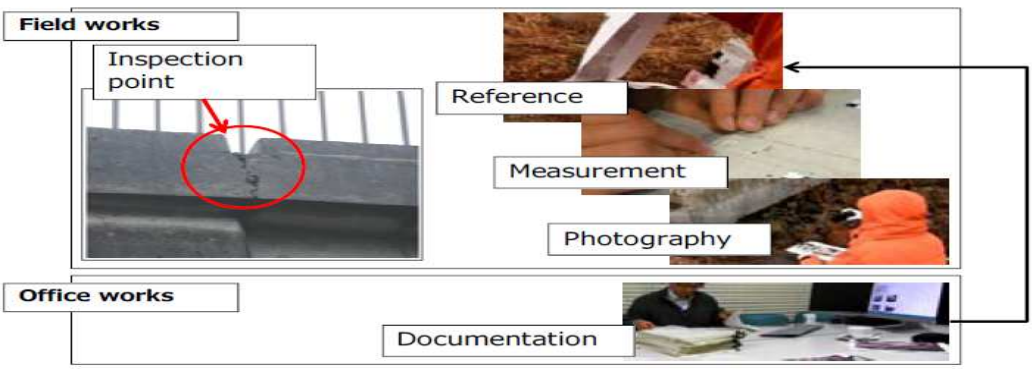

Fig. 1 Ground-based infrastructure inspection

Generally, the management focuses on the low life-cycle cost in a process of construction, maintenance, rehabilitation, and replacement. Based on this framework, a 3D geometric model is often generated based on building information modeling (BIM). Moreover, asset attributes, such as deterioration, condition, and age are acquired. To check the position of structures and structural elements and collect data related to these structures in frequent monitoring, there is a need to refer to maps, engineering drawings, and technical documents (Garrett et al. 2002). Reliability, completeness, efficiency, and cost are significant indices in monitoring. The reliability, completeness, and efficiency can be satisfied using terrestrial LiDAR, aerial LiDAR, and aerial photogrammetry using an unmanned aerial vehicle, as shown in Figure 2.

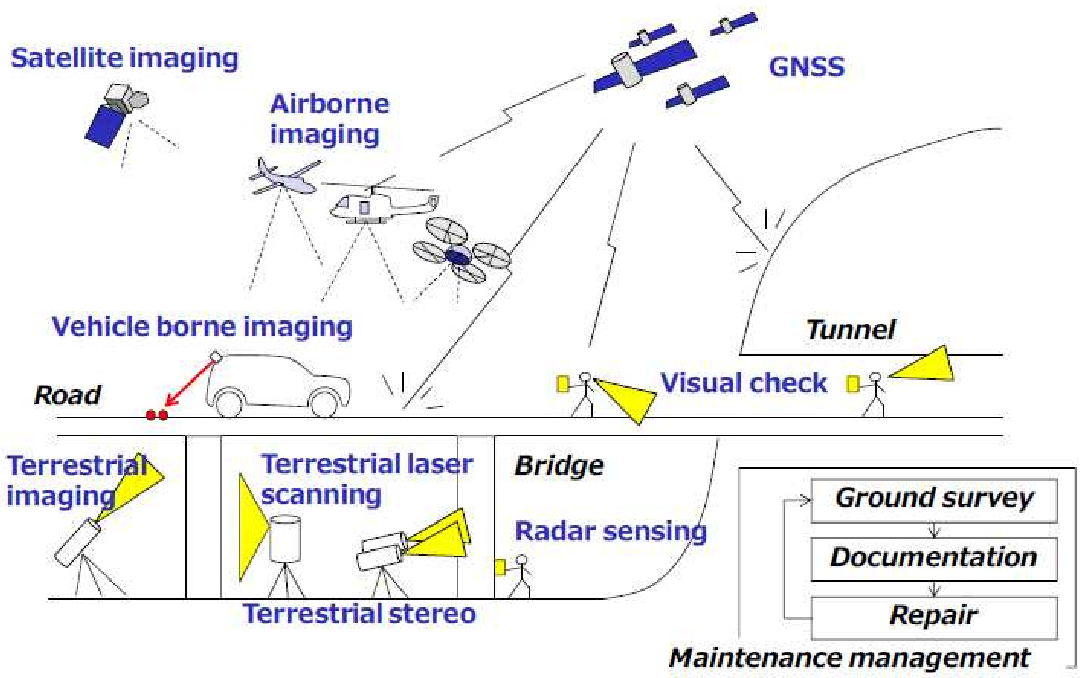

Fig. 2 Infrastructure inspection

In the current state, although 3D scanners can acquire high resolution data, it is not easy to acquire details of asset attributes with 3D measurements. Thus, we focus on ground investigation and inspection using mobile devices (Kamada et al. 2013). Field-based inspection requires some location-based applications, such as geo-tagged image acquisition, database interface, and navigation (Hammad et al. 2006). Mobile devices, such as tablet PCs, smart phones, and global positioning system cameras, have the potential to assist inspectors in infrastructure asset monitoring because of their built-in sensors and components that include cameras, GPS receivers, gyro sensors, Wi-Fi, microphones, speakers, vibrators, and large storage. Therefore, we aimed to assist investigators in infrastructure asset monitoring with location-based applications. In this paper, we propose and evaluate our location-based investigation application for Sabo facility management.

2. METHODOLOGY

Our proposed methodology for location-based infrastructure inspection is described in Figure 3. Our methodology consists of inspection operations with mobile devices and mapping with images to improve conventional inspection approaches.

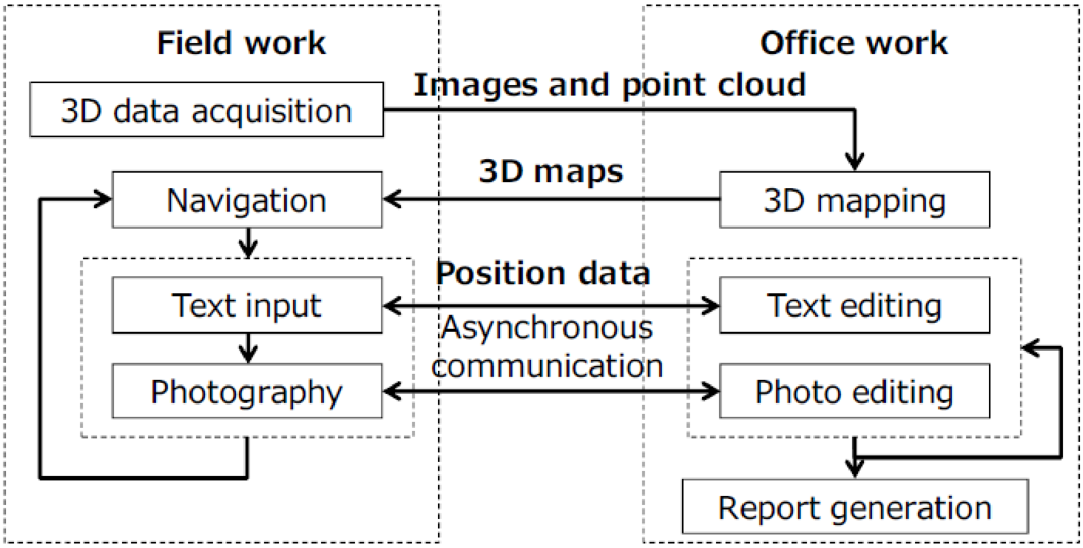

Fig. 3 Proposed methodology

2.1 Base map generation

In the BIM, base maps and 3D data are required to manage processes of construction, maintenance, rehabilitation, and replacement. Online maps, such as Google Maps and OpenStreetMap, are useful for infrastructure inspection in urban areas. However, in rural areas and mountainous districts, the online maps are often insufficient for infrastructure inspection to recognize the details of natural features. Thus, base maps and 3D data should be prepared before the inspection. In an open-sky environment, aerial photogrammetry and Structure from Motion (SfM) using UAV is more effective than ground-based scanning. On the other hand, when environments include natural obstacles, such as trees, terrestrial LiDAR is more effective than UAV. In
our research, we apply both approaches to prepare digital surface models (DSM) and digital elevation models (DEM) as base maps.

2.2 Mobile inspection application

The functions and performance of infrastructure inspection assistance with a mobile device, such as a tablet PC equipped with Global Navigation Satellite System (GNSS) receiver, are summarized in Table 1.

Table. 1 Functions and performance of infrastructure inspection assistance with a mobile device

Category A	･Display of maps, drawings, images, movies, and technical information ･Input of characters, lines, and shapes ･Adding a postscript to technical documents
Category B	･Documentation compatible with various template sheets ･Display of various types of maps and drawings (tiff, shp, sxf, dwg, etc.) ･Navigation in facility area ･Measurement (distance and area, etc.) ･Change detection ･User intuitive operability

Category A indicates essential functions and category B indicates additional functions. In addition, we propose a data model for our Web GIS-based mobile inspection application to satisfy the above-mentioned functions, as shown in Figure 4.

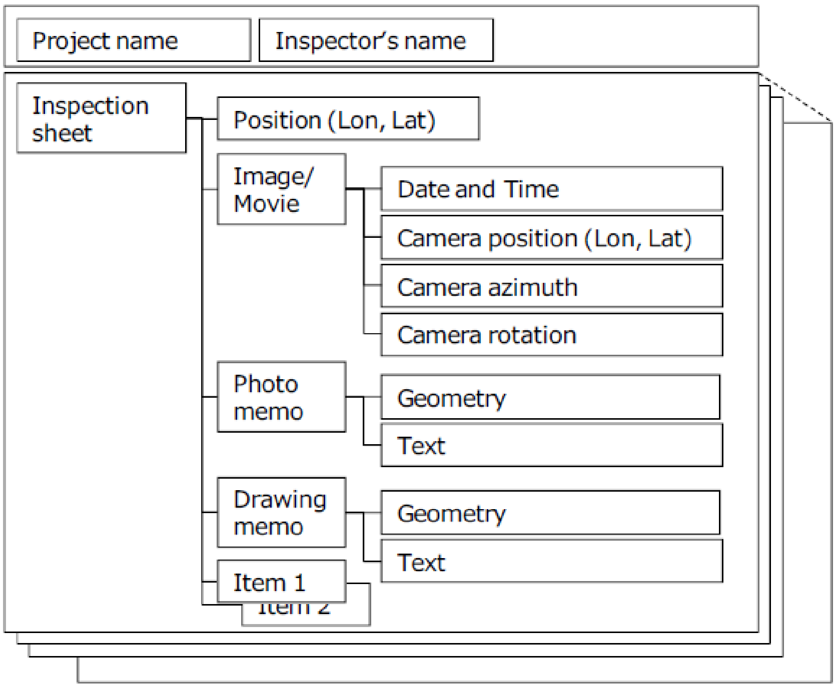

Fig. 4 Data model for our Web GIS-based mobile inspection application

An inspection work is subdivided into several activities, such as geotagged image acquisition, adding a postscript to a photo, and adding a postscript to an engineering drawing. Geotagged data generated from these works are managed with Extensible Markup Language to automate file export using an inspection template prepared by municipalities and a combination of managed data, such as maps, images, and movies, using position data as a retrieval key in inspection navigation. Acquired GPS data are mainly used for the management of location and time data. The location data included represent the position of structures, camera position data, and camera azimuth and rotation data.

2.3 Location data management

The required positioning accuracy is dynamically changed by each inspection work. For example, a closed photograph requires the same position (with approximately 1 cm accuracy) and direction (with approximately 1 degree accuracy) in the latest inspection to achieve automation of image registration for detection of any change in an infrastructure inspection (Nakagawa, Katuki, Isomatu and Kamada, 2013). On the other hand, inspection point detection requires lower positioning accuracy, from approximately 10 cm to 1 m. Moreover, in structure detection, positioning accuracy is allowed to be approximately 10 m. In addition, 100 m positioning accuracy is sufficient for an inspector's arrival in an inspection area. Thus, a definition with several steps or spatial resolutions is effective in location data management. In this research, these steps are represented as levels of details (LODs), such as LOD1: address, LOD2: structure, LOD3: inspection point, and LOD4: photography, as shown in Table 2.

Table. 2 LODs in infrastructure inspection

Levels of details	Content	Required accuracy
LOD1 **Address**	Inspector's arrival in an inspection area	100m
LOD2 **Structure**	Structure detection	10m
LOD3 **Inspection**	Inspection point detection	10 cm – 1 m
LOD4 **Photo management**	Documentation - Photography - Drawing	- 1 cm - 1 degree

3. EXPERIMENT

We conducted experiments involving the daily and annual Sabo infrastructure inspection work in a sediment-retarding basin consisting of dikes, bridges, and debris barriers in Fukushima, Japan (see Figure 5).

Fig. 5 Study area

3.1 Base map generation
We used md4-1000 (Microdrones) and PEN EP-1 (Olympus) (Figure 6) to acquire aerial 1000 images from 150 m height with 90 % overlaps and 60 % side-laps for SfM processing. Moreover, we used RIEGL VZ-400 (Figure 7) in our terrestrial laser scanning.

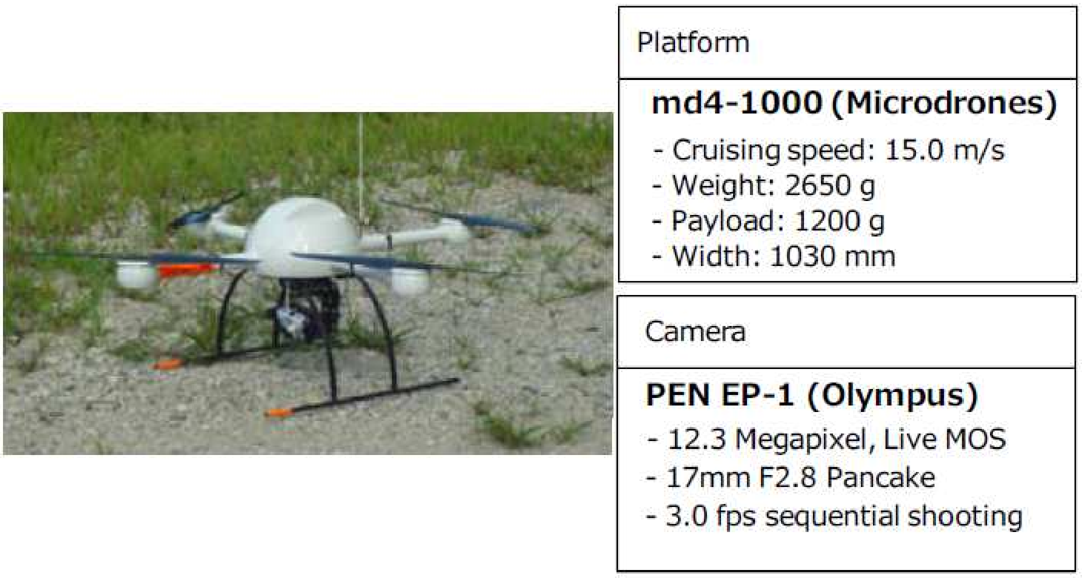

Fig. 6 UAV (md4-1000 and PEN EP-1)

Fig. 7 Terrestrial LiDAR (RIEGL VZ-400)

3.2 Attribute data acquisition

In attribute data acquisition, we record conditions of infrastructures, such as cracks, damages and displacements, based on checklists distributed by Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT). We assigned these checklists to meta-data and main data, as shown in Figure 8. Then, we input text data and images to record the conditions of infrastructures with some mobile devices, as shown in Figure 9.

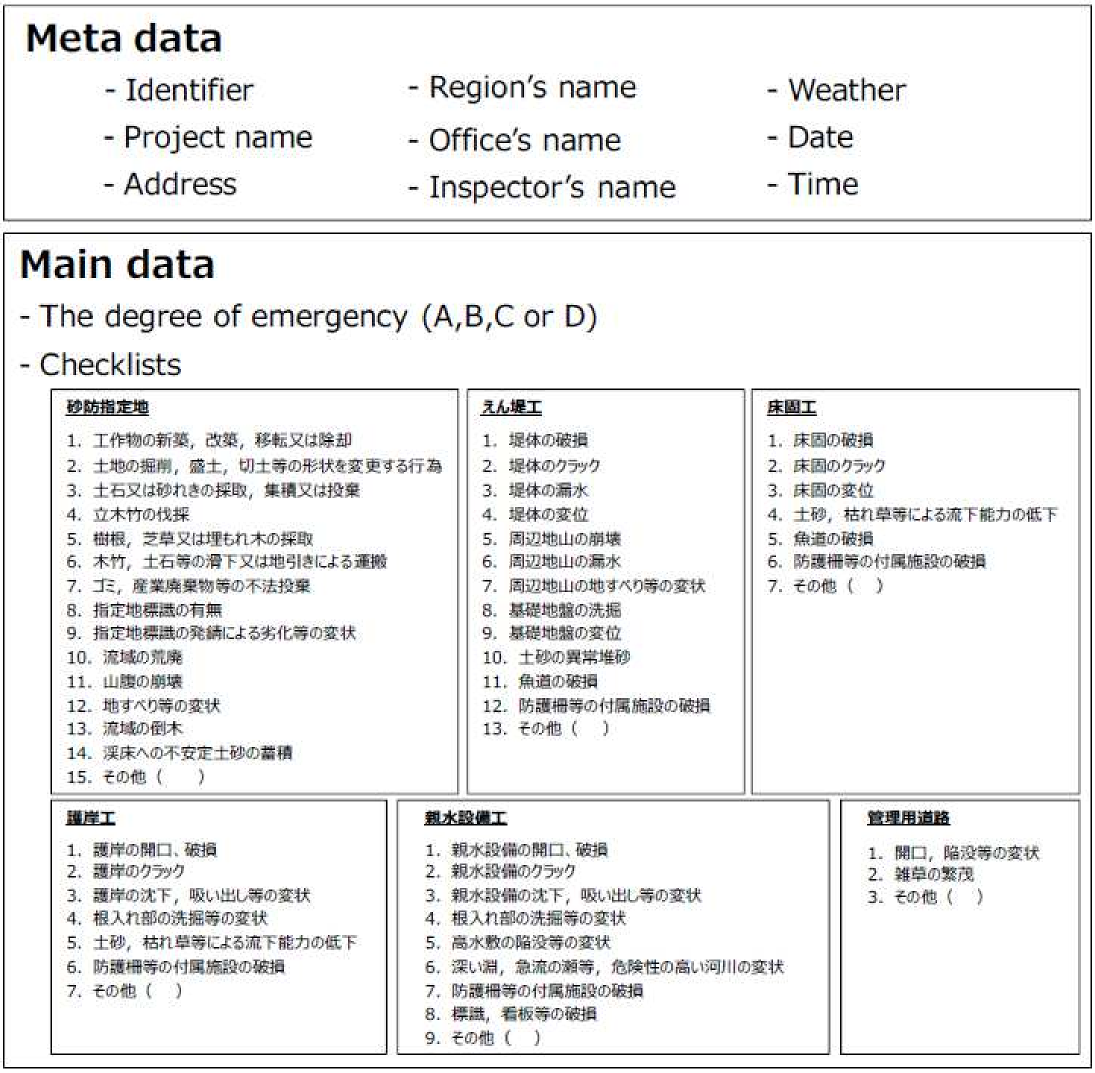

Fig. 8 Checklists in structure inspection based on MLIT's guidelines

In addition, omni-directional and close-range aerial images are also acquired to record attribute data of the conditions of infrastructures. These images are used to improve the integrity in infrastructure inspection with augmented reality applications in office works. We used two types of cameras, such as THETA m15 (RICOH) and QBiC PANORAMA (Elmo), to acquire the omni-directional images. These cameras were mounted on a monopod, as shown in Figure 10 and Figure 11. We also used a GPS logger (N-241, HOLUX) to get position data with omni-directional images. Acquired omni-directional images were stitched to be panoramic images and movies. These images and movies are viewed with a head-mount display (Oculus Rift), as shown in Figure 12. Moreover, we used a micro drone to acquire close-range aerial images with GPS/IMU data, as shown in Figure 13.

	**YOGA TABLET 8** - Android - CPU:1.2 GHz - RAM: 1 GB - 1280×800 px - GPS, Acceleration, Gyro, Compass
	**Xperia Z2 Tablet** - Android - CPU:2.3 GHz - RAM: 3 GB - 1920×1200 px - GPS, Acceleration, Gyro, Compass
	**iPad 1st** - iOS - CPU:1 GHzB - RAM:256 MB - 1024×768 px - Acceleration , Compass
	**Xperia VL** - Android - CPU:1 GHz - RAM: 16 GB - 1280×720 px - GPS, acceleration, gyro, compass

Fig. 9 Mobile devices (tablet PCs, smart phone)

Fig. 10 Panoramic video camera (THETA, RICOH)

Fig. 11 Panoramic video camera (QBiC, ELMO)

Fig. 12 Head-mount display (Oculus Rift, Development Kit 2)

Fig. 13 Micro drone (Bebop drone, Parrot)

4. RESULT

4.1 Base map generation

We generated a colored DSM with a ground resolution of 4 cm from the UAV. As shown in Figure 14, we have confirmed that ground surfaces, such as roads, gravels, trees, and water surfaces, were reconstructed well. Moreover, we acquired 114 million colored points (Figure 15) with from 7 points.

Fig. 14 DSM generated with images from UAV

Fig. 15 Point cloud acquired with terrestrial LiDAR

4.2 Attribute data acquisition

In our experiment, 213 images were acquired with mobile devices. Using geo-tag data, these images are reverse-geocoded into a map with GPS position data, as shown in Figure 16.

Fig. 16 Geotagged images

Then, acquired images are grouped into 36 viewpoints. In a manual work, it took 3120 sec. On the other hand, it took 4 sec in our position and azimuth filtering. Therefore, we confirmed that our application drastically shorten a work time for the image retrieval, as shown in Figure 17.

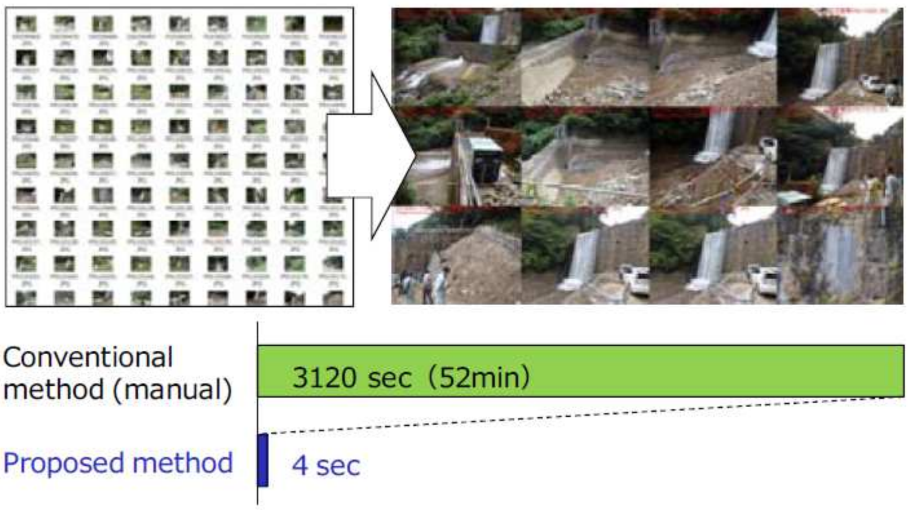

Fig. 17 Position and azimuth filtering result

5. DISCUSSION

Positioning from LOD1 to LOD3 requires from 100 to 1 m accuracy. Thus, single GPS positioning is suitable for position data acquisition. However, LOD4 requires 1 cm accuracy with precise positioning, such as a real-time kinematic GPS (RTK-GPS). Generally, low-cost inspection restricts the use of expensive devices such as an RTK-GPS. In low-cost inspection, the performance of satellite positioning is generally improved by assisted-GPS, differential GPS and multi-GNSS positioning using GPS, GLONASS, and QZSS. Data fusion of GPS and dead reckoning also improves the performance of positioning. However, although these approaches improve availability, they have almost no effect on positioning accuracy improvement. In this research, satellite positioning was assumed to have 1m accuracy, even if we could apply improvement approaches to positioning accuracy. Thus, a location data management approach using movies was applied in LOD4 (precise positioning). This approach assists inspectors to determine a position in a photography using a movie that was captured in the latest inspection and the attached approximate position data acquired with GPS.

5.1 Integrity of location data

In this research, we focused on a mobile application for infrastructure inspection, and location data management for inspection navigation. In fact, the availability of an application using location data depends on the integrity of the location data (Yabuki, 2013), and the integrity of the location data strongly affects location data browsing, and inspection recording and log browsing. Here, to improve the integrity, we focused on a combination of acquired data, such as location, photo and movie data. We classified three combinations among these data types, as follows.

a) Position (latitude and longitude), azimuth, and elevation angle Several minutes were required for detection of the previous inspection position. The most suitable procedure for the detection of the previous inspection position in our experiment was as follows. First, we referred to longitude and latitude to detect the position. Second, we referred to the azimuth angle using magnetic sensor data taken from a tablet PC. Third, we referred to an elevation angle using gyro sensor data taken from the tablet PC.

b) Position (latitude and longitude), azimuth, elevation angle, and photograph We determined the position for inspection with position, azimuth, and elevation angle data. Moreover, we could reconfirm the position with a photo taken in the previous inspection. However, when a difference existed between the position determined from position, azimuth, and elevation angle data and the position estimated from a geotagged photo, inspectors were unable to determine the true position for the inspection. c) Position (latitude and longitude) and movie We did not conduct an experiment related to video capture, which provides the shortest capture time and efficiency for navigation. However, we confirmed that an effective approach for inspection navigation was to capture a movie that shifted from a position that was far from an inspected point to one that was close. Moreover, we confirmed that a movie was a better approach than a picture for change detection in infrastructure inspection when an inspection point was in a complex environment, such as craggy places and Sabo sites.

5.2 Performance of operation using tablet PC

We qualitatively confirmed that automation of location and time data recording is more reliable than manual paper-based recording in infrastructure inspection. On the other hand, paper-based recording offers an advantage for documentation in an outdoor location, because text input with a mobile PC is time-consuming work. Moreover, we confirmed that raindrops worsen the performance of the touch interface, even when a waterproof tablet PC is used. Position data acquisition depends on single GPS positioning. Although our study area consisted of open-sky environments and structures, GPS positioning was insufficient for positioning in LOD3 (inspected position detection) in an area surrounded by mountains or under a bridge. On the other hand, we have confirmed that geotagged movie was effective in estimating the LOD3 and LOD4 position data. Even if position data included a positioning error caused by low dilution of precision and multipath transmission, an inspection position could be detected using movie guidance. Moreover, we could also focus on geotagged omni-directional camera data to detect an inspected position.

However, although we used Google Maps and OpenStreetMap as the base maps in our preliminary experiments, there was a difficulty in managing the frequent map updates. Therefore, we prepared DSM generated using images from UAV and DEM generated from a laser scanner as a more reliable base map. Although we prepared high resolution data, we used them as ortho images because it is not easy to view 3D data with tablet PC.
In addition, we confirmed that inspection work using a tablet PC held with both hands was dangerous on bad roads, in riverbeds, and in craggy places. Therefore, we would propose to use hands-free applications using wearable devices and voice-guided applications with geofencing techniques to improve safety in inspections using a mobile device.

CONCLUSION

In this paper, we focused on ground investigation and inspection using mobile devices. We aimed to assist investigators in infrastructure asset monitoring with location-based applications. We proposed and evaluated our location-based investigation application for facility management based on CIM. Through our experiment, we explored several issues in infrastructure asset monitoring using mobile devices. Integrity in positioning should be improved to achieve more reliable and effective inspection works. Therefore, we proposed an LOD definition for positioning data management in inspection works. Moreover, we proposed combinations of base maps and several types of data acquired with a mobile device in inspection works to improve reliability, completeness, and integrity in positioning.

ACKNOWLEDGEMENT

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Japan

Utilization of GPS/GNSS Big Data from Probe Vehicle for Traffic Management in the context of Nepal

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The University of Tokyo

Traffic management in one of the big issue in almost every urban city. Traffic management is even more serious problem in the context of Nepal especially in Kathmandu where there is no proper Traffic management system. This study focus on how the GNSS/ GPS data from the probe vehicle can utilized to extract the information about the traffic situation in a near real time basis which can then be used for managing/monitoring traffic situation. In addition, we focus on how the big geo spatial data can be processed efficiently and visualize to get meaning full information for solving urban issues. The importance of GPS/GNSS probe data is shown be showing the example from other countries where these technologies has already been implemented. In this case, we evaluate the probe GPS data of Bangkok, Thailand. The probe data has been implemented in Bangkok by Toyota Tsusho Electronics (Thailand) Co. Ltd where approximately 10,000 GPS devices has been installed in the Taxies running in and around the Bangkok. These GPS devices collect spatial and temporal information every 3 to 5 second. GPS data collected is then utilized from providing real time traffic information as well as monitoring. Finally, the presentation tries to elaborate more on utilization of GNSS/GPS technology on various field of remote sensing and geographic information system as well as how these data can be effectively utilized.

Japan

Location Spoofing – A Dangerous Vulnerability for GNSS

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Center for Spatial Information Science, The University of Tokyo, Japan

Location Spoofing is to falsify the location data in such a way that it looks like true location data. For example, a GPS signal generator can generate GPS signals similar to the signals from the GPS satellites in the space. When this signal is received by a receiver, the receiver does not know whether the signals are coming from the satellites in the space or a signal generator on the ground. It is possible to setup the signal generator to output location data as we need it. Even if the user is in Tokyo, it is possible to generate a signal so that the receiver outputs position data for Shinjuku. This is extremely dangerous if someone spoofs location data in this way.

Spoofing is one of the most dangerous vulnerabilities for GNSS. Vulnerabilities like Interference and Jamming can be detected by a receiver. But, spoofing can't be detected and is generally intentional. Though, the dangers of spoofing vulnerabilities have been raised in early 2000, not much work have been done so far. In near future, cars driving will be based on location data from GPS. Hence, if a car is spoofed for location data, this will pose life-threating incidents.

In this presentation, we present about what is vulnerability, how spoofing can be done and what we are doing to solve spoofing problem. A video demonstration will also be shown to explain spoofing. The video is also available at:
https://www.youtube.com/watch?v=PBQk9Jdk0f8

LatPos system for ionosphere monitoring and RTK applications

Didzis DOBELIS
GNSS Permanent Base Station Division
Latvian Geospatial Information Agency

Global navigation sattelite system continuously operating network of Latvia called LatPos is managed by Latvian Geospatial information agency since year 2005. LatPos consists of 25 permanent GNSS base stations over theritory of Latvia. LatPos is used for scietific purposes by different institutions. By law LatPos is declared as one of the geodetic networks in Latvia and approximately 400 users use LatPos for geospatial data acquisition.

Processing of GNSS data is getting more precise because of development of GNSS data processing software and it is important to determine and model the error sources.

Modelling of regional ionosphere over territory of Latvia has done with Bernese GPS v5.2 software. Ionosphere has modelled at different time epochs of solar cycle and they are close to global theories. High precision ionosphere models and maps can be calculated using regional GNSS base station systems. Calculated ionosphere models are used for further GNSS data processing.

Research on oportunities to use open-source software for near real-time GNSS data processing platform development to realize it in Latvian continuously operating reference network system „LatPos" has been done.

The study of reference station network transmitted RTK correction stability also has been carried out. Two different surveying class GNSS receivers in combination of four varied RTK correction techniques under diverse observation conditions are analyzed. This study has been conducted in territory of Latvia.

Malaysia

The variations of equatorial plasma bubble with solar and geomagnetic activities in Malaysia from 2008-2013

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Equatorial plasma bubble (EPB) is a 3D structure of ionospheric irregularity ranging from a few centimeters to thousands of kilometers. The spatial variations of EPB have been captured using various instruments such as optical imagers and radar echoes. The objective of this study is to report the spatial variations of EPB using rate of total electron content (TEC) index (ROTI) measurement. Two-dimensional map of ROTI can be derived from MyRTKnet which consists of 78 GPS receivers distributed over Malaysia (2oN - 6oN, 100oE - 120oE, dip equator 8oN). A ROTI keogram for one day period was obtained from the east-west cross section of the 2D ROTI maps at 5oN for every 5 min. The ROTI keogram was used to determine the occurrence of EPB by the enhancement of ROTI within the 100oE – 120oE longitude. The MyRTKnet have an advantage of providing time-continuous observation of EPB with broad geographical coverage. Therefore, MyRTKnet was able to capture the occurrence of EPB at any time along the observed longitudes. The results show that the occurrence day of EPB at any observed longitudes has no significant difference in low and high solar activity. However, the occurrence of EPB that occur successively along the observed longitudes show strong relations with solar activity. The dependence of EPB in Malaysia region show weak correlation with geomagnetic activity. The implications of this findings will be discussed.

Mongolia

Data analysis of permanent GPS networks in Mongolia

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[2]Institute of the Earth's Crust, the Siberian Branch of the Russian Academy of Sciences, Irkutsk, Russia

In Mongolia, several Continuous GNSS stations are operated and managed by different agencies, private companies and national scientific institutions and these stations have been built for purposes such as topography, cartography, cadastral surveying and crustal movement monitoring.

Institute of Astronomy & Geophysics of Mongolian Academy of Science has been established a CGPS network, includes 7 permanent GNSS sites which are focusing great scientific interest for seismic hazard aspects. The main objective of this network is the thorough investigation of the contribution of GNSS seismology (measuring the dynamic and static displacement with GNSS) to the characterization and quantification of earthquake parameters and, thus, to natural hazards monitoring and early warning systems. In this prospective, we developed automatic facilities to handle the Continuous GPS data archiving and data processing procedures.

We describe in detail the operations used to collect, archiving and processing the raw data in order to combine all these information into one uniform crustal velocity field. We also analyze the data of GNSS stations installed by Agency on Land Affairs, Geodesy and Cartography of Mongolia, selected considering their data availability trough time and their monumentation quality.

Results can be further used for geo-kinematics purposes, and for a better understanding of the active geodynamic processes that are deforming the Earth's surface in Mongolia and surrounding regions.

Comparative analysis of GNSS real time kinematic methods for navigation

Mourad BOUZIANI, Abdessalam El Kourk, Ayoub Bani
CRASTE-LF, IAV Hassan II

Currently the number of studies dealing with the PPP-RTK is limited, which makes it an important research topic. Our study aims to experiment this technique to test its performance in navigation. Indeed this research presents a comparative analysis of three kinematic methods namely the RTK PPP, the post-processing kinematic PPP and differential RTK. Regarding the first method we used the corrections from the IGS service in real time. For the second method we integrated the final corrections. For the third method, we used observations from the permanent station RABT.

GNSS processing for all three methods was performed by RTKLIB software. The results showed that the PPP-RTK can achieve an accuracy of less than 60 cm by using dual frequency receivers which is quite sufficient for an application of navigation.

Nepal

Coupling GNSS with the web APIs and Remote sensing algorithms for disaster management: use case for flood

Shuman BARAL, Janak PARAJULI

GNSS; the acronym, stands for Global Navigation Satellite System is the satellite navigation system which provides geospatial positioning (viz; latitude, longitude and altitude) of user's receivers globally. Natural disasters are inevitable worldwide phenomenon resulting tremendous loss of property along with human casualties. This paper is focussed in coupling the GNSS technology with web APIs for flood disaster management for preparedness, relief, rescue and recovery plan. With the wise use of GNSS, we can anticipate the loss due to natural disasters mitigated significantly, if not annihilated. The basic concept is to track flood level rise in rivers and streams to provide real time alerts to all the stakeholders and then its management and plan aftermath. Flood level rise is measured using sensor in river which sends message to primary or base warning station. The base station is equipped with devices receiving and transferring those messages to next level flood warning station along with stakeholders in the form of SMS and social media posts. The telecommunication messages with geospatial information are sent to web system for thorough analysis which can be disseminated in the form of thematic maps either online or offline via web servers. These maps can be used by governing agencies and humanitarian organizations for rescue planning and relief disbursement. Finally, in the nextphase, satellite images with GNSS collected data are used for quantification of damage estimation which can be used for sustainable recovery planning and rehabilitation. Thus, GNSS technology when wisely coupled with web APIs and ICTs, can effectively play important role in providing early warnings and emergency response. Search and rescue plannings can be highly efficient by the use of social media and mobile networks while remote sensing images can aid in quantifying damages.

Nepal

Disasters management system using GNSS

Ashok DAHAL, Pratichhya SHARMA
Tribhuvan University, Institute of Engineering, Pashchimanchal Campus

Introduction: Now a days in all mobile phones (smart phones) we all have GNSS receiver attached. In case of disasters like flood, earthquake and fire and in case of spreading disease like Ebola we don't even know where exactly is the origin of problem and in what extent it can harm. Government have the data of the shelters distribution and possible place to stay in the case of disasters but people don't have any idea about those places. To overcome such problem authors have designed The Disasters management system.

Methodology: We have designed an android app and a website which use the GNSS (GPS) receiver of the smart phone (or computer) and Web GIS technology. It use WFS connection from the web map server. There are 2 types of maps available one is for the disasters and another is for shelters. When user start the app (or opens website) GNSS receiver gets the current position of the user and create a buffer zone in some distance and displays all features inside or intersected by the buffer zone and returns features. App displays the returned data as the incident near the user such as flood and disease. The feature contains the spreading rate and effective area from that data app calculates the affective zone and suggest the user either s/he is safe or not. Another map is shelter map where the user can get the shelters near her/him and the information about the shelter i.e. what is the capacity of the shelter, is food available or not, is medical facility available or not. Last and main feature of this system is that user can request for aid like food rescue etc. just by clicking report. It is the crowd sourcing app in which user can just on the GPS of phone and upload incident like fire or disease near them and the system administrator can also add incident using GIS technology on those map. The request for aid are displayed through different map and rescue team can route to those place using the GNSS (GPS) and help out them fast.

Conclusion: This system is very useful at the time of disasters where victims of disaster can be benefited as well as the government can help people very fast. Using this system people can stay alert from incident such as flood and fire and help to save the life of people.

Note: Find the app at:
https://drive.google.com/file/d/0B7OuVtajCZvDZkQ1azNjakg3R28/view?usp=sharing

Habitat Suitability Analysis of Tigers in Chitwan District

Bipul NEUPANE

Nepal government has planned to double the population of tigers in Chitwan National Park (CNP) by 2022. This requires the protection and habitat suitability of the tigers. The poaching activity and the royal hunting reduced the population of tigers in Nepal in the past. But the poaching and hunting activities have reduced. In the year 2012, No-poaching year was celebrated in CNP. Also the human conflict is the major issue in the conservation of tigers. This project deals with the habitat suitability of tigers in CNP with and without considering the settlement.

Geospatial tools supported by ancillary geo-referenced data collected from the GPS devices and the terrestrial cameras by the WWF, and extensive literature review regarding the distribution of tiger and its prey in Chitwan district were used to build a tiger habitat suitability model. This consists of a geographical information system (GIS) based approach using field parameters and spatial thematic information. The estimates of tiger sightings, its prey sighting and predicted distribution with the assistance of contextual environmental data including terrain, road network, settlements were used to develop the model. Six variables in the dataset viz., forest cover type, slope, and distance from road, settlement, distance from river and prey were seen as suitable proxies and were used as independent variables in the analysis. A combination of the generated information and published literature was also used while building a habitat suitability map for the tiger. The modeling approach has taken the habitat preference parameters of the tiger and habitat of prey species into account. For prey distribution, the data was taken from WWF using attribute selection and export.

The results of the analysis indicate that tiger don’t occur throughout the district but occur throughout national park without considering settlement. The results have been found to be an important input as baseline information for population modeling and natural resource management in the Chitwan National Park. The development and application of similar models can help in better management of the protected areas of national interest.

The result shows that the suitable areas for the habitat of tigers has been occupied by settlement and roads in CNP which can be a major issue to the environmentalists involved in the conservation of tigers in CNP. The result also shows that without considering the settlement, there occur many suitable areas for the habitat of tigers. This helps the settlement planners for the construction. The tiger habitat suitability with restriction from road and settlement is also a result of this project.

Nepal

Application of Space Technology, including the GSNN, in the Healthcare Model of Nepal

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Developing countries like Nepal face various problems in the provision of medical services and healthcare. In spite of some visible improvement in the health statistics of the country, much more needs to be done to address the health needs, particularly in the sparsely populated remote and rural areas of the country The most common and urgent problems are severe shortage of healthcare professionals, insufficient or even total absence of healthcare services. In this context, Public Health Concern Trust, Nepal (phect-NEPAL), in co-operation with Nepal Wireless and Nepal Research & Education Network (NREN) has initiated a project entitled “A Resilient Healthcare Model for the Sparsely Populated Mountains of Nepal”. The project corroborates the agenda of the United Nations 2030 for Sustainable Development and its target set out for Sustainable Development Goals related to health.

Past projects in the remote mountains of Nepal have shown huge potentials of tele-health and tele-medicine. Nepal Wireless has been actively involved in the rural internet project to connect mountainous regions for the last 15 years. One of projects focused on tele-education/training by offering online educational content, video conferencing between teachers and students and telemedicine services through online or offline consultation using the internet and intranet. Within this project, a telemedicine center was established in some villages in Myagdi. A web based mobile application started to support pregnant women in rural areas is another practical example of the application of Information and Communication Technology in public health services.

The next step is to introduce the GNSS technology in the model. An example where the GNSS technology is of prime importance is the collection of spatially referenced data for tele-epidemiology. Vector and water-borne diseases and epidemics of weather and climate sensitive infectious diseases including malaria and cholera are prevalent in rural areas of Nepal. The use of GSNN together with the Geographic Information System (GIS) will allow the integration of ecological, environmental and other data to predict the spread of such diseases. Besides this, the above mentioned project also envisions use of mini-drones for the transportation of medical supplies and collection of specimens for laboratory tests. GNSS may be the best solution to operate medical drones. The augmentation of GNSS Real-Time Kinematic (RTK) will provide the necessary accuracy to precisely land medical drones in the defined spots.

The effectiveness of GNSS in tele-health has been well realized and hence, its integration is envisaged in the current healthcare model. An appropriate roadmap is planned to be developed by the middle of 2017. However, it is necessary to initiate collaborations with the relevant organizations in the regional and global level for the successful design and implementation of this model.

Nepal

Sun Earth Connection and Space Weather

Suman GAUTAM
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The Sun is a massive spherical body of gas held together and compressed under its own gravitational attraction. It belongs to spectral G2V with the magnitude of 4.8 and its size is rather small compared to many other stars in the sky. It is connected to earth in all bands of wavelength sending highly energetic particles ranging from Extreme ultraviolent radiation X rays and radio waves.

The sun exhibits an 11-year cycle of sunspots that are visible manifestations of increased solar magnetic field. The last sunspot maximum was in 2011 and the next one is expected in 2022. The maxima are somewhat broad and, for the purpose of space weather, last 3-5 years. During the sunspot maximum, the solar magnetic field is destroyed in solar flares, giving up its energy in solar ultraviolet (uV) light, x-rays, energetic particles (MeV protons), coronal mass ejections (CMEs), and a “stormy” solar wind. Coronal mass ejections and stormy solar winds frequently reach the earth if they originate on the part of the sun facing the earth. These ejections arrive as supersonic shock waves, frequently carrying high energy particles. Because the solar wind is fully ionized, it first encounters the earth’s magnetic field. The high energy particles can directly reach the upper atmosphere over the north and south poles, endangering transpolar air flights, space communication, satellites and Astronauts. This presentation focused on the physical process on the sun and sun earth connections. Finally Impacts of these ejections on the upper atmosphere will be highlighted and discussed.

Evaluation of Low Cost RTK GNSS System

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Softwel, Software development

Use of low-cost, single frequency GNSS receivers (Ublox Neo M8-T) to provide Real-Time Kinematic (RTK) positioning for mobile devices was investigated. An Android application was developed to interface with the Ublox device using a Raspberry Pi 3 through Bluetooth, and provide general mapping and feature recording capabilities. The Raspberry Pi 3 was programmed with RTKLIB for providing the RTK solutions. Cellular network was used to provide internet for connection to the caster for RTK correction. The arrangement provides accurate RTK positioning to the mobile device which was otherwise not available when using the inbuilt GPS. Option for PPK was also provided to record the phase data and process later on with the base station observation. A base station was established using PENTAX G3100-R1 and connected to internet caster to broadcast the correction. Additional investigation was also done using the Ublox M8-T connected to a Raspberry Pi 3 as a base station, which was connected to a caster for providing RTK correction to the rover. Tests were carried out for distances of 1 to 10Km from the base station. The investigation showed that mobile phones can be effectively used with a connection to low cost GPS receiver coupled with a Raspberry Pi for cost effective, sub-meter RTK positioning. The methods can be deployed in many practical applications such as tracking of vehicles, utility survey works, reconnaissance works and emergency mapping.

Space Weather at Low-Latitudes and Possibility of its Forecasting

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Space is the ultimate high ground from which a variety of satellite-based surveillance, communications, and navigation systems operate. As these technologies become increasingly intertwined into our day-to-day lives and national security, it becomes paramount to understand how they can be disrupted. When plasma in the ionosphere between a satellite and a receiver is turbulent, the transmitted signals scintillate. This scintillation poses a problem for a receiver, which can lose the ability to track that signal, adversely affecting technologies that rely on this system. Although low- to mid-latitude ionospheric irregularities have been studied for several decades, the capability to forecast their occurrence and day-to-day variability is still elusive and remains a challenge in space physics. In this presentation, our investigation of the morphology and dynamics of these ionospheric plasma irregularities is reported in great detail. We also present neutral dynamics and electrodynamics by comparing the equatorial plasma drift velocities with neutral winds to better understand the coupling physics at play. The results show that in the early evening hour, equatorial plasma bubble (EPB) velocity being slower than the neutral winds that reveal the F-region dynamo is not fully activated. While around midnight and post midnight hours, there is excellent agreement between zonal neutral winds and EPB velocities illustrating that F-region dynamo fully developed and the EPB velocity indicates as a background motion. These investigations are important to improve the predictability efforts of most low-latitude Space Weather Events, including the equatorial spread F (ESF).

Nepal

Impacts of Solar Storms on Energy and Communications Technologies

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Sun is the major source of energy providing heat and light to both living and nonliving on the earth but it has a temper too. Solar flares, Solar proton events, coronal mass ejections can have catastrophic impacts to technological systems around or on earth. They have been known to knock out satellites, power supplies, communications and navigations systems. Damage to these systems can result in secondary effects that can disrupt even major infrastructure on them including transportation security and emergency responses system telecommunication and other wireless network equipment and electronic equipment which can lead to significant economic losses. This presentation presents the various threats caused by these events to electronic communications and electrical system. In addition the necessary action to be taken to reduce these impacts are also discussed.

Nepal

Use of GPS in survey data error control and management

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National Society for Earthquake Technologies (NSET)

Building Code Implementation program, a project of National Society for Earthquake Technologies, uses Global Positioning System (GPS) data to control error of its surveys. It is most notably used in the Building Inventory Data Survey, where surveyors collect structural and socio-economic data of buildings of the region of interest. The survey data is collected on an electronic device, often a smartphone, which has built-in GPS receiver. Surveyors also locate buildings on paper maps by drawing footprints which is later digitized. The location from GPS receiver of survey device and footprint of the corresponding building is compared. This can be done in two approaches. One, after the survey is completed and two, while the survey is running. Both approaches have their own advantages and thus are better suited for different scenarios.

Nepal

Accident monitoring system using GNSS

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Road accidents are the major safety problem in the earth. In developed countries government have placed CCTVs over the road to record and view road accidents but in context of underdeveloped countries there are no sufficient way to monitor the road accidents. This project use GNSS to record the position of the vehicles when they are started until the engine is off, by installing this system every vehicle records its own position inside it. Traffic police can monitor accident using those data to answer how it happened, where it happened and which vehicle did wrong.

A GNSS receiver, a GSM module and a memory data logger are attached with a microprocessor (Simply Arduino). When the GNSS receiver gets carrier signal the Arduino process the signal and calculate the position of vehicle. The position is recorded in the memory data logger connected to Arduino the Arduino is programmed in such a way that it record vehicle position every 10 seconds. It can be considered as Continuously Operating Moving Station(COMS). By knowing time and position information Arduino calculates velocity of vehicle and record in different column. Position recorded are then saved in memory data logger. GSM module have a special SIM-card having 10 digit vehicle identification ID (Actually phone number of SIM card). By calling to that number from any mobile network the GSM module returns the current position of the vehicle. In many countries when motor bike collides with the truck then truck have to pay fine but by implementing this system the position of every vehicle is recorded inside a flash drive so that after the accident traffic police can get the actual position. Plotting the data in any GIS software and giving some buffering Range police can know route of vehicle at the time of incident.

By using this instrument all the vehicles position are recorded and we can also know location of vehicle even they lost. Memory data logger contains velocity and position information. Traffic police can know which vehicle was travelling in which direction then monitor accident and punish the actual guilt rather than larger vehicle.

Analyzing the performance of permanent GNSS stations

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Satellite navigation systems provide the basis for development of numerous technology and socio-economic applications related to navigation. The significance of satellite navigation makes Global Navigation Satellite Systems (GNSS), a crucial technology, and an element of national infrastructure. With the launch of new navigation systems and the availability of Multi-GNSS receivers, GNSS networks such as Continuously Operating Receiver Systems (CORS) are now being set up and growing at an exponential speed to provide better GNSS signals to the data users. However, this technology is still prone to natural and artificial influences that affect its performance and operation, therefore one of the major concerns of existing and potential GNSS users is the availability of good quality GNSS signals. A GNSS application that requires continuous data (e.g. deformation monitoring, precision agriculture and environmental monitoring) will encounter a major fault if the data is not available continuously. For this reason the GNSS users and operators need to have specific standards for Data Quality Check (QC).

Technically the permanent network is composed of three parts: a network of properly distributed stations, an infrastructure for dependable communication, and the control centre. The control center monitors the stations to make sure that the GNSS users in the vicinity are receiving accurate corrections. In order to do so, the first step is to ensure that the stations themselves are available at all times and receiving reliable data from the satellites. Software to monitor the GNSS data in real time has been developed and is being used to analyze the GNSS signals at all times. However, this is not enough; the data must be post-processed regularly to check the key parameters of GNSS signal over the course of the day.

The presentation will highlight the key parameters that are used to assess the GNSS data from the permanent stations. The presentation will also highlight the necessity of and methodology for quality check of GNSS data received from this network. Subsequently, details of all the necessary parameters that must be considered when checking the quality of GNSS data will be presented. These parameters include signal power, positioning errors, cycle slip and multipath. Obtained result from an already deployed network of permanent stations in Pakistan will be presented and discussed.

A new Geoid Model for the Philippines

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The National Mapping and Resource Information Authority (NAMRIA) with the technical assistance of the National Space Institute, Technical University of Denmark (DTU-Space) and funds from the National Geospatial-Intelligence Agency (NGA) of the USA for the airborne survey has computed a preliminary geoid model for the Philippines i.e. Philippine Geoid Model 2014 (PGM2014). The geoid was computed using data from land gravity, airborne gravity, marine satellite altimetry and the newest satellite gravity data from the GOCE mission release 5. Digital terrain models used in the computation process was based on 15” SRTM data.

The geoid is computed in a global vertical reference system shifted with a constant of +80 cm to approximate the average geoid offset relative to GNSS/Leveling in Manila (BM-66) for a geoid-based vertical datum. To keep the existing vertical datum, a corrected ITRF GNSS/Leveling was fitted to the computed geoid for a Mean Sea Level (MSL) – based geoid system.

A new model has been computed (PGM2016) after reprocessing the original land gravity data and densifying the gravity stations from 1261 to 2157 points. To refine the geoid, further densification of the land gravity to 41,000 points will be conducted until 2020. GRAVSOFT system of FORTRAN routines developed by DTU-Space and Niels Bohr Institute, University of Copenhagen was used in computing the Philippine geoid.

Russian Federation

GLONASS Programme Update

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The presentation will focus on programmatic issues, current status and modernization of GLONASS system. It will cover the background principles of the government policy behind GLONASS Program implementation.

GLONASS deployment phase is complete and the GLONASS Sustainment, Development and Utilization Program is deeply under way bringing new opportunities to users and new challenges to the Government. The presentation will give some review of the modernization efforts carried out currently with respect to space segment, signals, augmentations and applications.

The presentation will also include a brief summary of GLONASS Augmentations. With the increasing role of GLONASS as one of the fully operational systems user support activities become more important. The presentation will also briefly address the User Information Center of Roscosmos and its activities.

Thailand

A pilot GNSS timing station in Thailand geodetic network

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Thailand plans to provide a national geodetic network by integrating the Global Navigation Satellite System (GNSS) Continuous Operating Reference Stations (CORS) that are currently in operation and to be newly installed by several Thai government agencies. This is a four-year plan starting from 2015 until 2018. The coverage is nationwide with network real-time kinematic services, precise point positioning services and other location base services. This network will be vital tools for positioning, navigation as well as timing. National Institute of Metrology Thailand (NIMT) will take part as a GNSS timing station of this national geodetic network by using a geodetic quality receiver equipped with an external frequency standard called caesium frequency standard; maintained as a Thailand national timescale named UTC(NIMT). The remainder GNSS CORS use their internal crystal oscillators. The timing station at NIMT is planned to be linked internationally with the global network of the International Bureau of Weights and Measures (BIPM) for time and frequency comparisons. This paper highlights recent challenges for NIMT as a timing station in order to make use of GNSS code and carrier phase measurements to obtain the availability of accurate and stable time nationwide. The results are recent experiments at NIMT as a stand-alone timing station using a GPS geodetic quality receiver with the insertion of 10 MHz from a UTC(NIMT) timescale. The timing accuracy is at 2.81×10-13 and its stability is about 5.03×10-14 averaged in 1 day; compared to GPS system time.

Ukraine

Positioning and Timing and Navigation System in Ukraine: European Cooperation Aspects

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Ukraine has developed the Positioning & Timing and Navigation System using global navigation satellite systems (GNSS). This System has been established in the framework of the National Space Programs of Ukraine (1998-2012) and on the basis of standards adopted by the European project EUPOS.

Main tasks of the System are: continuous monitoring of GNSS signals and integrity of radio-navigation fields of GPS, GLONASS, EGNOS, Galileo and BeiDou GNSS, forming and distributing via Internet the differential corrections for governmental authorities, governmental scientific and industrial enterprises, commercial enterprises and individuals in Ukraine.

These tasks may be also performed with the help of:
- Development and operation of the System, participation in European programs EGNOS and Galileo.

- Implementation of commercial projects in the field of satellite navigation, including public-private partnerships and GNSS international cooperation programs.

According to the Cooperation Agreement on a civil global navigation satellite system (GNSS) between the European Community and its member states and Ukraine, which entered into force in 2014, the extension of EGNOS to the territory of Ukraine is planned to be implemented through the ground infrastructure involving Ukrainian Integrity Monitoring Stations.

Ukraine implements measures on extension of the satellite navigation system EGNOS/Galileo to Ukraine, and carries out close cooperation with the European Commission experts to choose location for the RIMS installation in Ukraine.

The Ukrainian RIMS will cover the entire territory of Ukraine as well as the eastern part of the EU (Romania). The service will be provided within the land and air borders of Ukraine, where Ukraine is responsible for the international air navigation.

Achieving these objectives will allow creating business opportunities for both national and European companies, as well as generating public benefits for the Ukrainian economy.

Solar Cycle 24's Effects on WAAS and EGNOS

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Solar Cycle 24 will go down in history as one of the lowest solar cycles in over a hundred years. Now past the peak of the 11-year activity cycle, Cycle 24 end with a smoothed sunspot number maximum of 116 in April 2014, making it the smallest sunspot cycle since Cycle 14 which had a maximum of 107 in February 1906 (http://solarscience.msfc.nasa.gov).

Generally, near the peak of a solar cycle we see a significant increase in the number of space weather events such as solar radio bursts, solar flares and coronal mass ejections (CMEs). These events can affect the performance of ground- and space-based technological systems, with results ranging from minor digital upsets to severe power grid disruptions that can cause loss of service to millions. For Global Navigation Satellite System (GNSS) users, space weather events can ultimately degrade ranging measurements affecting the performance and availability of many applications that are built into our modern daily lives.

For aviation augmentation systems such as the Wide Area Augmentation System (WAAS) and the European Geostationary Navigation Overlay Service (EGNOS), geomagnetic storms that result from solar flares and CMEs are the most threatening of solar events. This was demonstrated in October 2003 when a series of large X class solar flares associated with coronal mass ejections that generated loss of availability of the WAAS Approach with Vertical Guidance (APV) service for many hours over the entire service volume. Similar effects were seen in response to other large solar flares and CMEs in November 2003 and in November 2004. Solar Cycle 23 certainly provided challenges and direction for improvement and development of future augmentation systems. Although WAAS and EGNOS have shown a response to Cycle 24 space weather events with degraded availability of vertically guided approach services, the systems have not been confronted with geomagnetic storms of the intensity seen in earlier solar cycles. One of the reasons is that the Cycle 24 geomagnetic storms are weak, even though the number of solar flares and CMEs haven't dropped off very much. Scientists have suggested that reduced pressure currently present in the heliosphere have weakened the magnetic field inside the CMEs resulting in milder geomagnetic storms (Gopalswamy et al. 2014). Even still, during this very mild solar cycle, strong CMEs following major X class solar flares have occurred, such as the extreme event of July 2012 (Ngwira et al., 2013), simply not directed towards Earth, leaving the open question whether a major event with significant performance degradation can be observed even during a quite solar cycle.

In this paper, we will review the characteristics, frequency and magnitude of the space weather events of Solar Cycle 24. We will discuss the methodology used by WAAS and

EGNOS to detect geomagnetic storms and we will illustrate the impact these storms have had on the WAAS and EGNOS systems identifying those times when the systems were most challenged. Finally, we will make a comparison with solar cycle 23, in order to understand what may be expected in the next cycle in terms of number and severity of events and to introduce the challenges for dual-frequency services provided by WAAS and EGNOS in the future.

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Uzbekistan

Modification of the reference frame of Uzbekistan topographic maps

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Mapping and positioning of Central Asia were started by Abu Rykhan Beruny in XI century for the irrigation. In 19th century there were developed accurate topographic maps on the basis of a triangulation and of a leveling, which were referenced to the Bessel-ellipsoid, 1841.

The territory of Central Asia has not homogeneous structure and complex for mapping. It is located in a seismically active region along the Eurasian tectonic plate, resulting in frequent earthquakes. Therefore, the geodetic coordinates change due to plate tectonics, as well as industrial processes. These coordinates are maintained by the network of high-precision geometric leveling of the 1st and 2nd classes. Before 1940 all geodetic measurements were based on the SK32 (Origin: Sablino, Russia.1930, Bessel-ellipsoid, ΔX=382m., ΔY=151m., ΔZ=574m., Δa=739.845, Δf= 0.10037483. Now, the reference frame of topographic maps does not meet modern requirements in terms of accuracy and efficiency. The establishment of the national reference frame is not an easy task because Earth's crust continuously undergoes various deformations.

In order to meet the demand for sustained economic and social development in the 21st century, the modern datum system of surveying and mapping was established to adapt to the high-tech development. They are the renewal and modernization of the national or regional geodetic datum, on the other hand, they continue to update and refine the geodetic reference framework and focus on geodetic mingled with other disciplines and to expand the scope of geodetic services.

The main focus of this study is to improve the geodetic reference frame for the topographic maps. Reconnaissance, updated geodetic points, the SK42, WGS84, modification of Gauss-Kruger coordinate systems and GIS are given in this work. The modification of the map projection, develop of an additional reference frame and using of CATS network are described. An additional reference frame based on the modification of Gauss-Kruger projection is more suitable for topographic maps of 1:100000 - 1:5000 scales, where difference between two projections is ywgs84 – ysk42= 64m. , xwgs84 – xsk42= 9m. , hwgs84 – hsk42= 37m.

The CATS network provided a control for three-dimensional geocentric coordinate system for the Central Asia, and the accuracy has improved at least two orders of magnitude compared to that of "SK42", that means a new stage occurred in space geodetic network construction in Uzbekistan. The transition to the additional reference frame will help the surveyors and geodesists to use modern coordinates. The territory of Uzbekistan covers 10,11,12,13 zones of six degree zone. Using of the 6 degree zone is more correct for the wide territory. It is suggested to use a 1 degree zones to reduce distortions in Uzbek topographic maps at the edges of the zone.

To correct the vertical datum for the national reference frame it is necessary to create a new model quasi-geoid of the southern region of Uzbekistan. The digital elevation model of Kashkadarya region was constructed with the help of GIS PANORAMA, where normal and geodetic height relative to SK42 and WGS84 were used. At the initial stage it is better to use a topographic sheet maps with application of the additional reference frame based on the WGS84. For the best transformation model and reduce the fit errors, it is need to use data of the GNSS.