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Interviews

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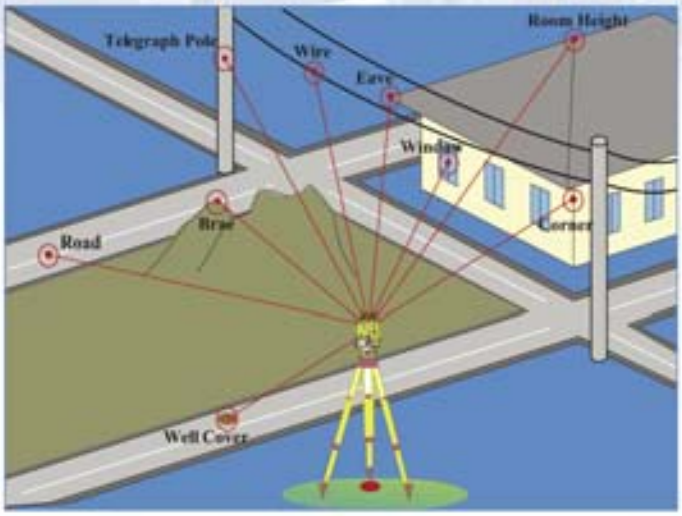

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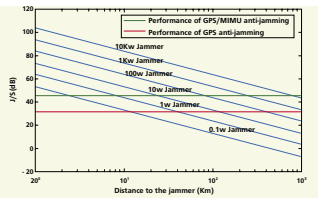

Columns

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Music to the ears

There is news.

That too a good one.

Reportedly, all 4,800 maps of the Survey of India will be available in public domain.

As many as 2,900 are of open series.

It would happen by March end.

The commitment(!) comes from the Minister himself. The Minister of Science and Technology, Government of India.

It looks like actualization of NSDI has been initiated.

Sounds like music to the ears.

Many of us would like to hear it.

April, in any case, is not too far.

Till then, let us keep our fingers crossed.

Bal Krishna, Editor
bal@mycoordinates.org

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Satellite navigation cannot solve everything

Prof Dr Güenter W Hein, Director of the Institute of Geodesy and Navigation, University FAF, Munich, on GNSS trends, applications and challenges

Prof Dr Günter W Hein

Please tell us about the focus of research at your Institute.

The Institute of Geodesy and Navigation of the University FAF Munich with presently more than 30 research associates from various disciplines (aeronautics, electronics, geodesy, informatics, techno-mathematics and physics) and various countries has three main research lines: Galileo and modernized and new GNSS, Receiver Development (mainly GNSS software receiver) and Sensor Fusion (integration of GNSS with other techniques like inertial, telecommunication, WLAN, etc.)

Highlight for us the challenges that the research community should take up?

There is no doubt that using GNSS for indoor positioning is a hot research item. We now have to come up with a new generation of Galileo and GNSS receivers which provide more capabilities for the user, perhaps through integration with other techniques, more robust, small and cheap to manufacture. Research communities come up when they recognize the huge commercial potential. You find now that every day so-called incubators are born. We are only at the beginning.

What technological trends do you see in GNSS?

The main trend I see is the integration of GNSS with other techniques. We know satellite navigation is a nice technique but cannot solve everything. We like to see seamless navigation in future, from outdoor to indoor, for an aircraft from gate to gate, for all applications – but that can only be achieved by integration with other sensors, data and techniques.

Which are the key application areas emerging in GNSS?

The recently published GALILEO Green Paper on Satellite Navigation Applications shows a variety of applications. By the end of this year we may have many mobile phones equipped with a GPS or GNSS chip. It is also true that we can hardly imagine how many applications we will have in the next decade – this is probably not so much constrained by technology but rather because of our limited imagination.

Do you view Galileo as a complement to US GPS or competition?

With the agreement between the EU and USA on 28 June 2004 ("Agreement on the promotion, provision and use of GALILEO and GPS satellite-based navigation systems and related applications"), a major milestone was reached for the worldwide user: to work with one simple receiver which is able to track both, GPS and Galileo. This means neither competition nor complementing GPS – it means cooperation of two global navigation satellite systems to get a significant redundancy in satellite observations for more availability, accuracy and integrity of many satellite navigation applications. The user will then not care in future whether he receives Galileo or GPS satellite observations.

When do you foresee Galileo as a reality?

We expect that a full Galileo system will be available from 2012 on. One of the present challenges is to solve the funding of the system: Can we realize Galileo as a so-called "public-private partnership" where governments and industry are investing in it, or do we have to consider Galileo as a modern infrastructure (like GPS) which governments provide to their citizens in the 21st century? The other challenge is to define in detail the Galileo Public Regulated Service, who are the users, and its applications. What are the measures to provide the necessary protection? There is no doubt that in Europe – now with 27 countries – it takes time to get consensus among all the member states.

Do the regional initiatives of India and China complicate the scenario?

First of all it is remarkable to see what kind of worldwide move in satellite navigation Europe has initiated ever since it started with the development of Galileo. It certainly shows a great impact of satellite navigation over the next few decades and a great potential in many applications affecting every citizen. However, given the fact that frequency resources are limited, it also means that all the big players have to sit at the table

to solve the accommodation of the various signals in the frequency band. Moreover, trying to serve all users in the best way, we should start to coordinate the future "Global Navigation System of Systems".

What is your perspective on geodesy education?

Satellite navigation is an interdisciplinary field not yet covered properly by space sciences. That is also the reason that you find only a few universities in Europe and worldwide covering it in more than just a single module in a certain lecture. We are therefore starting soon an Executive Master program on satellite navigation at our university for young engineers working already in the industry. We will also organize this year for students and young researchers between 02 to 10 Oct. 2007 the "First International Summer School on GNSS: A Worldwide Utility" in the Berchtesgaden area (south of Germany in the alps where the Galileo Test Environment, GATE, is starting its operation in April 2007) with international lecturers and in cooperation with Stanford University, Palo Alto, Ca. We also have many contacts in Asian and Australian universities and are trying continuously to improve these relations through exchange.

Prof Dr Günter W Hein is Director of Institute of Geodesy and Navigation at the University FAF, Munich. Prof. Hein´s main interest is the development of Galileo, Europe´s global navigation satellite system, where he serves as German delegate in the EC Galileo Signal Task Force. Prof. Hein received the 2002 Johannes Kepler Award for "sustained and significant contributions to satellite navigation" from the US Institute of Navigation.

Do you see any emergence of proper interface between industry and academia?

There is no doubt that a close cooperation of universities with industry is necessary in satellite navigation. We are working with our institute that is always in consortia with the industry. I can only recommend that to all of my colleagues – it can be a win-win situation for both.

Rapid alignment process for tactical grade IMU

A hybrid alignment scheme that combines an Adaptive Neuro-Fuzzy Inference System and Kalman filter to improve the accuracy of initial attitude angles and reduce the consumption of time

YUN-WEN HUANG, YU-SHENG HUANG AND KAI-WEI CHIANG

Inertial navigations systems (INS) use onboard sensors such as accelerometers and gyroscopes. Both sensors consist of three orthogonal axes. Axes of both sensors are parallel and the origin is defined as accelerometers. These sensors are fixed in the body of the IMU and form the body frame with fixing sensor axes. Accelerometers output specific force along three axes of the body frame; gyroscopes output angular rate about the same axes. Both sets of measurements are made with respect to an inertial frame of reference. Inertial positioning, therefore, is based on the simple principle that differences in position can be determined by a double integration of acceleration, sensed as a function of time, in a well-defined and stable coordinate frame [El-Sheimy et al., 2004].

In order to provide navigation solutions (i.e., position, velocity, and attitude) using the specific forces and angular rate provided by an IMU, an INS mechanization which consists of the orientation of the IMU with respect to the navigation frame is needed. The relationship between navigation frame and body frame is described using the transformation matrix R_b^n. However, the transformation matrix needs to be updated continuously since it works on a moving platform. The accuracy of those navigation parameters depends on the initial value of the transformation matrix R_b^n. The process of computing the initial value of R_b^n is known as the alignment of an IMU [El-Sheimy et al., 2004]. Alignment is accomplished with coarse alignment (CA), and fine alignment (FA). The purpose of the CA is the determination of approximate values of the attitude angles (roll, pitch, and heading) between the body frame and navigation frame. The FA, then, refines the CA estimated attitudes using an iterative optimal estimation technique [Savage, 2000].

The CA process provide a quick orientation of the platform with respect to the navigation frame using the accelerations and angular rates obtained directly from the sensors without consideration of their errors [Jekeli, 2001]; on the other hand, FA provides optimal estimate algorithm to estimate the error of inertial systems. Thus, the obtained accuracy from alignment process depends mainly on the performance of the inertial sensors, i.e., sensor biases and output noise [Salychev, 1998]. Since the only signals during stationary alignment process that can affect the inertial sensors are the Earth's gravity and the Earth's rotation rate, the autonomous alignment method can be done only when the gyro bias is smaller than the value of the Earth's rotation rate [El-Sheimy et al., 2004]. In addition, measurement errors, especially gyro bias, would extend the time needed to perform an accurate alignment. Since a key benchmark figure for many INS based navigation systems is the amount of time the INS needs to achieve readiness for navigation, considerable effort goes into devising fast, but accurate alignment and initialization procedure [Jekeli, 2001]. Recently, some of the alternative techniques have been developed to improve the accuracy of estimated by the Kalman filter; for example, El-Sheimy et al., [2004] incorporated wavelet denoising technique with Kalman filter to accelerate the alignment process with improved accuracy.

On the other hand, Artificial Intelligence (AI) techniques have been applied to develop alternative INS/GPS integration schemes to overcome the limitations of Kalman filter and improve the positional accuracy of a vehicular navigation system during GPS signal blockages successfully [Chiang, 2004]. However, there are no active research works associated with applying AI techniques to improve the accuracy of alignment. Therefore, the objectives of this article are to: (1) develop a hybrid alignment scheme using an Adaptive Neuro-Fuzzy Inference System (ANFIS) and Kalman filter to achieve faster alignment with higher accuracy in comparison with a conventional scheme that uses a Kalman filter and (2) verify the performance of proposed scheme using several field test data that were collected independently.

Kalman Filtering

The essential process in any inertial navigation algorithm is mechanization process. The INS mechanization equations integrate the accelerations and angular rates provided by the inertial sensors (accelerometers and gyroscopes) to compute the position, velocity, and attitude (PVA) of the vehicle [Wong, 1988]. The algorithm takes into account the earth rotation rate and gravity. These mechanization equations can be simply presented as follows:

$$\begin{bmatrix} \dot{r}^l \\ \dot{v}^l \\ \dot{R}_b^l \end{bmatrix} = \begin{bmatrix} D^{-1}v^l \\ R_b^l f^b - (2\Omega_{ie}^l + \Omega_{el}^l)v^l + g^l \\ R_b^l(\Omega_{ib}^b - \Omega_{il}^b) \end{bmatrix} \quad (1)$$

where

r^l is the position vector [ϕ (latitude), λ (longitude), h (height)],

v^l is the velocity vector (V_{east} V_{north} V_{up})

R_b^l is the transformation matrix from the IMU body to local frame as a function of attitude components,

g^l is the gravity vector in the local level frame,

$\Omega_{ib}^b, \Omega_{il}^b$ are the skew-symmetric matrices of the angular velocity vectors $\omega_{ib}^b, \omega_{il}^b$ respectively, and

D^{-1} is a 3x3 matrix whose non zero elements are functions of the user's latitude (ϕ) and ellipsoidal height (h).

For further discussed details of solution and numerical implementation of the above differential equation, see El-Sheimy [2002]. An INS mechanization algorithm by itself is seldom in good performance due to the inertial sensor biases and the fixed-step integration errors, and these errors will cause the PVA solution to diverge quickly. The navigation software must have some approach to account for these error sources to correct the estimated PVA [El-Sheimy et al., 2004].

The dynamic error model used in a KF for the navigation parameters (position, velocity and attitude) can be determined through the linearization of the INS mechanization equations and by neglecting insignificant terms in the resultant linear model. A simplified form is then obtained as [Bar-Itzhack and Berman, 1988]:

$$\begin{aligned} \delta \dot{r}^l &= D^{-1}\delta v^l \\ \delta \dot{v}^l &= -(2\Omega_{ie}^l + \Omega_{el}^l)\times\delta v^l - \delta R_b^l f^b + R_b^l \delta f^b + \delta g^l \\ \delta \dot{A}^l &= E\delta v^l + R_b^l \delta\omega^b \end{aligned} \quad (2)$$

where

δr^l is the position error state vector in the local level frame,

δv^l is the velocity error state vector in the local level frame,

δA^l is the attitude error state vector in the local level frame,

δg^l is the error in the computed gravity vector in the local level frame,

$\delta f^b \& \delta\omega^b$ are accelerometer bias and gyro drift vectors in the body frame respectively, and

E is a 3x3 matrix whose non-zero elements are a function of the vehicle's latitude and the Earth's radii of curvatures.

In addition to the nine navigation elements (equation 2), states of the dynamic model include the sensor errors (three accelerometer biases and three gyro drifts). It is a common trend to model the stochastic part of these sensor errors as first order Gauss Markov process The state space representation of dynamic error model is of the form:

$$\dot{x} = Fx + Gw \quad (3)$$

where

x is the error state vector of inertial navigation containing the following 15 states:

$[\delta\phi,\ \delta\lambda,\ \delta h,\ \delta v_x,\ \delta v_y,\ \delta v_z,\ \delta p,\ \delta r,\ \delta A,\ \delta w_x,\ \delta w_y,\ \delta w_z,\ \delta f_x,\ \delta f_y,\ \delta f_z]^T$

F is the dynamic matrix,

G is the noise coefficient matrix

w is a zero-mean Gaussian white noise vector.

The KF estimate these elements using a form of feedback control. The equations of KF are divided into two groups of equations [El-Sheimy, 2002]; prediction and update. The time prediction equations are responsible for the forward time transition of the current epoch (k-1) states to the next epoch (k) states. The time prediction equations are [Gelb, 1974]:

$$\hat{x}_k(-) = \Phi_k \hat{x}_{k-1}(+) \quad (4)$$

$$P(-) = \Phi_k P_{k-1}(+)\Phi_k^T + Q_{k-1} \quad (5)$$

where

P is the estimated variance-covariance matrix of inertia states,

Q is the system noise matrix,

(–) denotes the estimated value after prediction, and

(+) denotes the estimated value after updating.

The measurement update equations utilize new measurements into the a priori state estimate to obtain an optimized a posteriori state estimate. The measurement update equations are given as:

$$K_k = P_k(-)H_k^T[H_k P_k(-)H_k^T + R_k]^{-1} \quad (6)$$

$$\hat{x}_k(+) = \hat{x}_k(-) + K_k(Z_k - H_k\ \hat{x}_k(-)) \quad (7)$$

$$P_k(+) = P_k(-) - K_k H_k^T P_k(-) \quad (8)$$

where

K is the Kalman gain matrix,

Z is the vector of updating measurements of position and velocity,

R is the measurements variance-covariance matrix

Fundamentals of fuzzy logic and anfis algorithm

Fuzzy logic is unique in that it is able to simultaneously handle numerical data and linguistic knowledge. It is a nonlinear mapping of an input data (feature) vector into scalar output, in other words, it maps numbers into numbers [Mendel, 1995]. Fuzzy logic systems has been considered as an alternative approach which is able to cope with uncertain information and to provide a framework for handling uncertainty and imprecision in real-world application. It accomplishes this by allowing computers to simulate human reasoning with less bias, but, in the process, to behave with less analytical precision and logic than conventional computing methods [Turban and Aronson, 2000]. Unlike the traditional hard computing, soft computing strives to model the pervasive imprecision of the real world. Solutions derived from soft computing are generally more robust, flexible, and economical than those provided by hard computing [Malhotra and Malhotra, 1999].

Fuzzy inference systems (FIS) have recently gained reputation as well established means of utilizing human

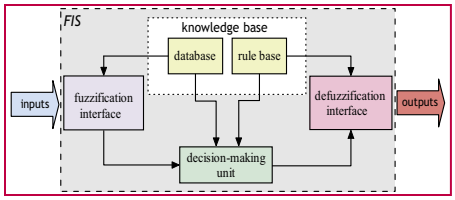

Figure 1: Fuzzy inference system

intelligence machines. There are three types of fuzzy inference systems, which are used in different engineering applications: the Mamdani FIS, the Tagaki-Sugeno-Kang (also known as Sugeno) or the TSK-FIS and the Tsukamoto fuzzy inference systems (TS-FIS) [Sugeno 1985, Jang et al. 1997 and Cordón et al. 2001]. They are different in their methods of fuzzification of the input space, defuzzification to the output space and aggregation [Reda Taha et al., 2003], while all FIS use similar logic. In this paper, TSK-FIS shall be used for modeling unknown process. A fuzzy inference system is composed of five parts, as shown in the Figure (1).

A rule base containing a number of fuzzy if-then rules which are capable of describing the desire system behaviors, and a database defines the membership functions of the fuzzy sets used in the fuzzy rules. Usually, the rule base and the database are jointly referred to as the knowledge base [Jang, 1993]. It is the decision-making unit which performs the inference operations on the rules. Fuzzification is defined as the process of mapping numerical inputs to the fuzzy domain of the model which ranges between zero and one using membership functions. These membership functions define how much each data point belongs to each data set or cluster in the input space. On the other hand, defuzzification is regard as the process of transferring the aggregated fuzzy sets at the output space to a single value that represents the membership of the output parameter to the aggregated fuzzy set [Reda Taha,. et al., 2003]. The defuzzification process is usually done using the centroid function in Mamdani systems [Mamdani and Assilian, 1975] and the weighted average in Tagaki-Sugeno-Kang (TSK) systems [Sugeno, 1985].

Neuro-fuzzy systems have been proven as efficient modeling techniques for mapping non-linear systems (e.g. Gallo et al. 1999 and Chae et al. 2001). A novel architecture called Adaptive Neuro-Fuzzy Inference System (ANFIS) serve as a basis for constructing a set of fuzzy if-then rules with appropriate membership functions to generate stipulated input-output pairs. ANFIS was proposed in order to combine the advantages of both neural networks and fuzzy inference systems [Jang et al. 1997]. A simple ANFIS architecture can be schematized in the Figure (2):

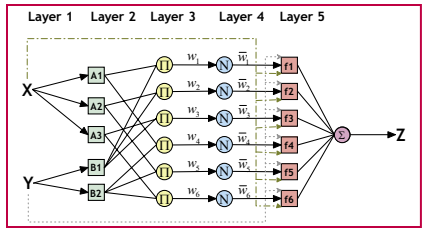

Figure 2: A general ANFIS architecture

Fig. 2 illustrates a possible architecture of ANFIS for two-input one-output system. Input X is assumed to have three membership functions and two membership functions for input Y. Fuzzification process is done at layer 1. The fuzzified inputs which mean weights are normalized using a T-norm operator at layer 2. At layer 3, the ratio of every rule's firing strength and the sum of all rules' firing strength is calculated, and the fuzzy rules are applied at layer 4. Finally, the output Z in layer 5 is gained by the sum of the weighted outputs of all fuzzy rules.

ANFIS algorithm is basically a technique which provides a method for fuzzy modeling procedure to learn information about a given data set to compute the membership function parameters that best allow the associated fuzzy inference system to track the input/output data. This learning method is quite similar to the training of neural networks and combines back-propagation and least mean square optimization algorithm. In addition, the membership functions are tuned with gradient decent method to determine the premise parameters. Training won't stop until the preset epoch number or error rate is obtained.

ANFIS-KF Hybrid Scheme

The Kalman filter (KF) is utilized to optimally estimate the initial attitude errors as well as the sensor biases and compensate for their effect. This process usually requires about 10 to 15 minutes of static data for tactical-grade IMUs. The observations (updates) for .the KF, in this case, are Zero Velocity Updates (ZUPTs). Due to the relatively large measurement noise of the inertial sensors, especially for gyroscopes, usually need more time for the KF to converge [El-Sheimy et al., 2004].

To accelerate the INS alignment process and obtain those initial attitude angles with higher accuracy, an intelligent compensation method can be implemented to predict the error in fine alignment procedure. During the alignment process, the outputs of Kalman filter might contain the errors that can not be estimated well due to the limitations mentioned in Chiang [2004]. Consequently, the overall accuracy of estimated attitude angles can be deteriorated. In addition, Kalman filter requires more time to converge. Therefore, an algorithm that can predetermine the error behavior of Kalman filter is needed. Hence, an ANFIS-KF integrated algorithm is delivered to do so. Once it has been trained well, The ANFIS is expected to work efficiently to compensate the errors predicted by the KF used.

As indicated in Figure (3), the errors of roll, pitch, and heading estimated by Kalman filter are used as the desired output or target values during the learning process of three different ANFIS architectures, respectively.

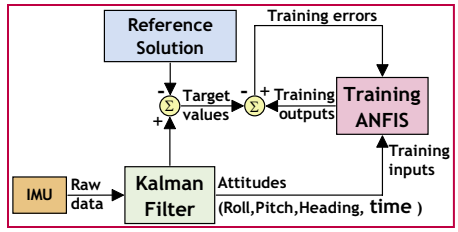

Figure 3: An ANFIS training architecture

*Once again history repeats itself

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It is decided to use three separated architectures instead of one because the error behaviors of roll, pitch, and heading vary. In addition, the roll, pitch and heading angles along with the time information in each scenario are used as the inputs for those architectures, respectively.

In this article, the target values, the initial attitudes errors of the Kalman filter, were obtained with respect to reference solution which is generate by the post mission process (e.g. smoothing algorithm) using a high-accuracy navigation grade IMU. The parameters of membership functions of the ANFIS are then tuned epoch-by-epoch according to the training error. The training process terminates after the training errors reach the error threshold. This process can be regarded as the training mode of the proposed hybrid scheme.

After being well trained, the proposed ANFIS architectures can then be utilized in compensation or prediction mode when the new measurements provided by an IMU in alignment mode are applied. Similar to the training mode, the hybrid architecture first receives raw data from an IMU then uses a 15 states Kalman filter in ZUTPs mode to estimate initial attitude angles, meanwhile, the estimated attitude angles are sent to proposed ANFIS architectures along with time information in each scenario to generate predicted errors for compensating the estimated angles provided by the Kalman filter simultaneously. Errors of three attitude angles are predicted with three different ANFIS architectures, and the correction would be completed after the predicted errors have been removed from the outputs of KF. A prediction process is illustrated in the Figure (4). It is worth mentioning

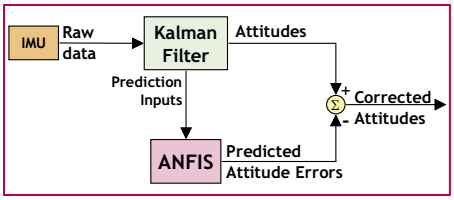

Figure 4: An ANFIS prediction architecture

that the proposed architectures can be operated in real time for compensating those initial attitude errors.

Exprimental result

In order to examine the effectiveness of the proposed ANFIS-KF model, three field test data (provided by the MMSS group at the department of geomatics engineering, the University of Calgary) incorporating a tactical-grade IMU, LN200 (Litton) and navigation-grade IMU, CIMU (Honeywell). Three field data were collected under different environment and time. Therefore, these filed data can be considered independent from each other. The setting of LN200 and CIMU is shown in Figure (5). The axes of LN200 are basically aligned together with the axes of CIMU in order to provide reference solutions. The reference solutions were generated in post-mission mode using a navigation grade IMU, CIMU.

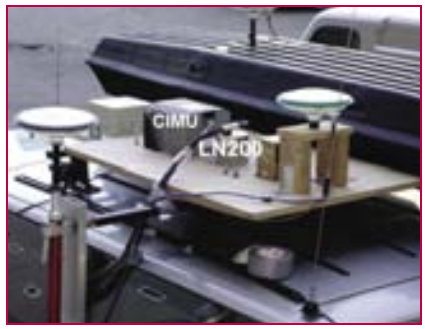

Figure 5: Setting of LN200 and CIMU

The first test data was utilized as the training data. The length of this data set is 300 seconds. Since the ANFIS was trained by 1st test data, it learnt the estimated error behaviors of the attitude angles provided by the Kalman filter using the same data set very well. As indicated in the Figure (6), the estimated attitude errors were almost removed through compensation process using the proposed scheme. In addition the Root Mean Square (RMS) errors of proposed scheme and Kalman filter are listed in Table 1. As stated previously, since the training data set was utilized

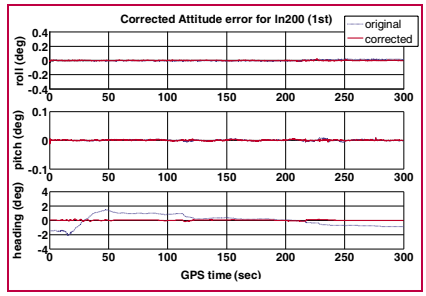

Figure 6: Compensated attitude errors (1st data set)

as test data set in this scenario, the attitude errors estimated by Kalman filter were compensated well.

To evaluate the performance of proposed scheme in prediction mode, two field test data sets that were collected independently from the training data set were applied as the test data sets. The time spans of those data sets are 300 seconds and 70 seconds, respectively. Figures (7) and (8) demonstrate the enhancement after applying compensation scheme. As indicated in both figures, there are no significant improvements after applying proposed scheme for compensating roll and pitch errors as those errors are well estimated using Kalman filter. However, the heading errors in both scenarios are well compensated in term of the magnitude of the heading error as

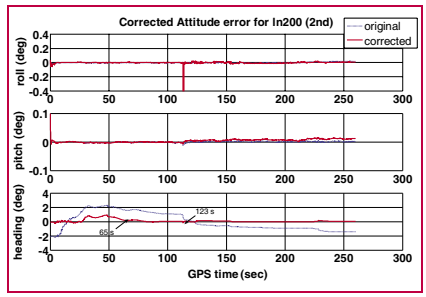

Figure 7: Compensated attitude errors (2nd data set)

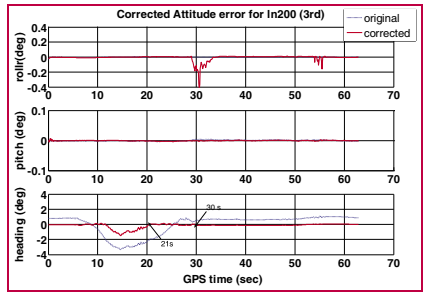

Figure 8: Compensated attitude errors (3rd data set)

Table.1: RMS value enhancement after compensation

Field test	Attitude Angle	RMS value(degree)	
		original	corrected
1st	roll	9.394e-3	2.468 e-3
	pitch	2.209 e-3	1.424 e-3
2nd	heading	0.7907	0.0463
	roll	6.799 e-3	0.0564
	pitch	3.899 e-3	7.003 e-3
3rd	heading	1.2548	0.2406
	roll	2.902 e-3	0.0401
	pitch	1.978 e-3	1.308 e-3
	heading	1.2949	0.3323

Table 2. Alignment time enhancement after correction

Field test	Alignment time of heading (sec)		Improvement (%)
	original	corrected	
2nd	123	66	35.8%
3rd	30	21	30.0%

well as the time span for convergence. The significant improvement in heading errors in accuracy and time after applying compensation scheme are listed in Tables 1 and 2.

As indicated in the Figures (7) and (8), the time epochs for convergence in heading errors are indicated by arrows.

As presented in Table 1, the improvements in heading errors after applying compensation scheme reach 81% and 74%, respectively. In addition, Table 2 verifies the improvement in convergent time to be 36% and 30%, respectively. In other words, based on the field test data sets applied in this article, the proposed scheme is able to provide a faster alignment procedure with superior accuracy in compensating heading error, which is the most difficult element to estimate during normal alignment process.

Conclusion

This article exploited the idea of developing a hybrid scheme to reach faster IMU alignment with higher accuracy using a novel procedure that combines an ANFIS architecture and Kalman filter. The ANFIS architectures were trained first to learn the error behaviors of Kalman filter using the field data set collected with a tactical grade IMU (LN200). Then the proposed architectures were evaluated in terms of the accuracy and time using two field test data sets that were collected independently from the training data set using the same system.

The preliminarily results presented in this article indicate the improvements in heading errors after applying compensation scheme reached 81% and 74%, respectively. In addition, the compensation schemes were able to reduce the alignment time by 36% and 30%, respectively. In other words, based on the field test data sets applied in this article, the proposed scheme is able to provide a faster alignment procedure with superior accuracy in compensating heading error, which is the most difficult element to estimate during normal alignment process.

The future works of this study will be extended to investigate the impact of IMU raw data as well as the comparison of proposed scheme with other alternative schemes developed using Artificial Neural networks.

Acknowledgments

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GIS for economic development

Second ESRI Asia-Pacific User Conference, 18-19 January, 2007, New Delhi, India

The Second ESRI Asia-Pacific User Conference under the theme of "GIS for economic development" was held at Hotel Taj Palace, New Delhi, India on January 18-19. Organized by ESRI India, the event witnessed participation from more than 900 delegates from all over the Asia Pacific region.

Mr Rajesh Mathur, President, ESRI India, explaining the purpose and the importance of the event, spoke about how various users can benefit by sharing their work and experiences in the field of GIS. He also gave a brief walkthrough of the conference and a short profile of ESRI India. A session about the ESRI Technology Directions was presented by Dr David Maguire, Director of product ESRI, where he acknowledged the ESRI and NIIT alliance and then briefed about various applications of GIS.

There were three Keynote speakers amongst the dignitaries. Prof Josef Strobl, Director of Center of Geoinformatics, spoke on 'E-Learning for Carrier Advancement' addressing two major sections, GIS Science and Education and E-Learning. Dr Devendra Pandey, Director General, Forest Survey of India, gave a brief description of the Forest Survey of India and how remote sensing and GIS are being implemented in their projects. Honorable Jeremy Harris, talked about how the city of Honolulu, Hawaii, with 1 million population, every department of the city was tied into one central Enterprise Wide GIS Infrastructure, which in turn helped the city to overcome the problems faced due to urban sprawl, traffic jams, air pollution, deforestation, improper waste management etc.

Mr Rajendra S Pawar, Chairman, NIIT Technologies Ltd, described his two engagements in the past year - the university which is being planned half way between Delhi and Jaipur where GIS helped develop the master plan, and the Rajasthan Government's Economic and Policy Review Council where GIS helped analysis of the free power given to the farmers and the decrease in the water table. Dr David Maguire gave a brief overview of ESRI's GIS products and mentioned the newly launched portals, ArcGIS Online and ArcWeb Services. Mr Damian Spangrud, Senior GIS Manager for ArcGIS Desktop, demonstrated some of the new productivity

Sensitizing decision makers towards technology

In a unique and first of its kind initiative to educate prospective audience about the technology, a Senior Executive Seminar was organized by ESRI India on January 17, 2007 in New Delhi. The seminar was attended by around 70 participants. Mr Rajesh Mathur, President, ESRI India, highlighted the importance and relevance of such an effort. Prof AR Dasgupta, Former Project Director, NRIS, Space Application Centre, shares his experience on the National Natural Resource Information Systems (NRIS). He highlighted the users' requirements, policy issues, and many other aspects that should be considered while managing a large GIS project. Dr K K Agarwal, Vice Chancellor, GGS Indraprasth University emphasized on developing an understanding on cost of implementation vs cost of non-implementation of GIS in any developmental project. Honorable Jeremy Harris, Former Mayor, City of Honolulu, in his presentation 'Enterprise wide GIS for sustainable cities', demonstrated the cost of investment against the benefits while explaining the successful experience of Honolulu city. Dr David Maguire, Director – Product Planning, ESRI, made a strong presentation 'Building a business case for GIS'. There were also presentations by Dr D Pandey, Director General, Forest Survey of India; Mr Chang Kwok-fai, Lands Department, Hong Kong; Ajita Kini, Hindustan Construction Company; and Prashun Datta, Reliance Energy. The seminar was chaired by A K Mukerji, Former Director General – Forests, Ministry of Environment and Forests, Government of India and seminar rapporteur was Bal Krishna, Editor, Coordinates.

enhancements for the desktop. Dr. Sudhakar Menon, Lead developer, ArcGIS and Geodatabases, described the use and effectiveness of publishing data to servers without programming.

A technical quiz was organized by ESRI India in which three teams participated - Center for Earth Sciences and Studies (CESS), National Informatics Center and RRSSC. CESS managed to win with NIC as first runners up and RRSSC second runners up. The official sponsors, Hewlett Packard (HP), spoke about servers becoming better and affordable and technology becoming personal, friendly, and easier. There was also a mention of ESRI HP alliance for testing the software and hardware respectively. The second day of the conference started with three technical workshops - "what's new in ArcGIS 9.2" presented by Mr Damian Sprangrud, "ArcGIS Server 9.2 and The Geodatabase – Key Features and Concepts" presented by Dr. Sudhakar Menon, and "ArcGIS 9.2 – Spatial Analysis and Modeling Capabilities" given by Dr David Maguire. This was followed by a session with Mr. Mathew O'Connell, CEO and Chairman, GeoEye, where he shared his vision about the present and future scenario of satellite imagery and the forward plan of GeoEye.

A total of 34 papers were presented on GIS for economic development, natural resources, and E-Governance, followed by Student Papers. Mr Jack Dangermond, President ESRI, concluded the days events by emphasising the need to share information and data over different networks. He proposed a GeoWeb where anyone can share, view, and work on the information that is clubbed from different sources to perform critical analyses.

Paper Session Awards:

- First Award – 'School score card' by Dr Rajiv Sharma, Mrs MG Bala Prassana, Sanjay Kumar Tiwary and Mr Dakshinamurthy
- Second Award – 'GIS based water compliant redress system: an Effort towards e-governance' by Prof Anjana Vyas
- Third Award – 'Real time monitoring of forest and tree cover in west bengal as in 2006' by Mr Atanu Raha
- Aware for Best Student's Paper – 'Development plan for a township using GIS' by MrAshish Arora and Ms Ranjana Pushkarna

Poster Session Awards:

- First Award – National Atlas Thematic mapping Organisation (NATMO), Kolkata, India
- Second Award – World Wide Fund for nature (WWF), New Delhi, India
- Third Award – Andhra Pradesh Remote Sensing Application Centre (APRSAC), Hyderabad, India

Tension between surveying and GIS: A growing challenge

Jack Dangermond shares his observations with Coordinates

Q Challenges that Coordinates should focus on

A big challenge is integrating the surveying profession with the GIS profession. There's a growing tension between them. One of the bridges that I want to accomplish this year is integrating the technology so the surveyors can have tools within the GIS toolbox that allows it to create and manage surveys that can be directly used by the GIS people. The GIS datasets, in turn, can be refined based on survey information, especially transaction based survey. These two goals are separate and sometimes they run into a big conflict about who should do what. I think I would be technically directing them and say these technologies can be synergist. There is a need to search out surveyors that want to grow their activities in the GIS areas and search out GIS people who want to have a strong survey inclination.

Geomatics growth in India

It's been about 10 to 12 years since I first came here and at that time it seemed like the Dark Ages. There was nobody who knew what I was talking about. There's satellite mapping, and then automated mapping, other parts of the GIS that was stressful. And then about 10 years ago, we had our first conference and there were a few dozen people who came and they were all right on the edge of their particular agencies of professions. Today, my gosh! this conference could have been held in Western Europe, or in United States. We felt very comfortable with the level of quality of the papers that were presented, the models were very sophisticated. And I think it will just spin out of control in this way when more and more people get in. Also the international market for GIS people started off where India seemed to be the data conversion house. Later it gave more application programming. Now it's becoming consultants. These are step-by-step revolutions to where India will see GIS and with that revolution, I find it challenging and surprising that there are not more university people here to grab the technology to teach with. There's huge job opportunities for people in GIS.

Next milestone in GIS?

Microsoft and Google have shown how there's a thirst for Geo spatial visualization. They want to do much more than that. But people need to fathom the images they look at and understand how to interpret the entire gamut of geo spatial information. That's just quite an expanse…We need GIS professionals not only to run projects and run advanced systems but also ensure other people have access to their knowledge of technologies and web services…

"One should not rely on a single source for PNT information"

Navigare Necesse Est is the Latin tag that underpins the basic necessity of all forms of life to find their way to survive and prosper. Today's new world of ubiquitous electronic navigation supremely illustrates that dictum. Says Dick Smith, newly elected President of the International Association of Institutes of Navigation (IAIN)

Would you like to explain IAIN's purposes?

Various institutes of navigation [ION] around the world came together in the 1970s to form an international association for the exchange of information and the provision of impartial advice on navigation matters. It has grown successfully, not merely in membership size but also in representation at relevant international bodies.

Who are IAIN's members?

The 20 member institutes of navigation come from 29 countries, alphabetically ranging from Australia to the United States of America. Each member pays an annual subscription depending on the size of their membership roll. Nominally the largest institute is from China, with the United Kingdom following as second and the smallest member institute from the Czech Republic.

How does IAIN discharge its purposes?

- Exchange of information between members (and for anyone else who wishes to read our website at www.iainav.org) is mainly via our quarterly Newsletter and a tri-ennial Congress. The latest Congress was held in Jeju, Korea in October 2006 and the next will be in Stockholm, Sweden in 2009.
- One of our member institutes, The Royal Institute of Navigation, is the world lead in organising quadrennial conferences on animal navigation, a fascinating field of research capturing increasing attention.

The areas of explosive growth are on the land – vehicle and pedestrian

Captain RA SMITH was previously Secretary General of IAIN, Chairman of the European Group of IONs and President of the Royal Institute of Navigation. He spent 35 years in the Royal Navy, mostly at sea. He is a Younger Brother of Trinity House, Fellow Royal Institute of Navigation, Fellow of the Nautical Institute, Fellow Chartered Institute of Management, lay member of the Institute of Chartered Accountants of Scotland and Fellow Royal College of Physicians of Edinburgh. He hastens to add that the latter is in a non-medical category! He has recently been nominated as a member of the US Space-based Position, Navigation and Timing Advisory Board.

- Co-ordinated advice on navigational matters has always been available at national and regional level. IAIN advice at world level has been achieved mainly via the various international governmental organisations. At the International Maritime Organisation [IMO], for example, we contributed very much to the early development of traffic separation schemes and in the International Civil Aviation Organisation [ICAO] we participated in the work for the then future air navigation systems. We are also an observer at the International Hydrographic Organisation [IHO] and recently shared a positive contribution in the deliberations at the UN Office of Outer Space Affairs to form an International Committee on GNSS [ICG].

What thoughts lay behind your Latin navigation tag quote above?

I have always grasped the fundamental necessity for most walks of life to be able to get from one location to another in order to survive, whether they be man, bird or beast. That involves navigation, albeit some of it done by instinct. Man has raised that basic level of navigation by introducing other means of transport by land, sea, air, and space. All of these have led to navigational advances over the centuries.

Our current era of electronic navigation (e-nav) has brought remarkable positioning, navigation, and timing [PNT] capabilities to a wealth of users. Many of those users will not

know how they are provided with such information, but nonetheless they will rely, unconsciously, on navigation. They indeed will depend on 'The New Navigators', an expression coined elsewhere, to safely design and sensibly produce a myriad of electronic devices.

Institutes of navigation can help by providing the fora for keeping the professionals up-to-date and also by informing lay users of system's general capabilities and limitations.

Do you have any concerns about the enav era?

No more than any other prudent navigator. Essentially, one should not rely on a single source for PNT information. Always use other navigation aids to double check and provide the necessary, but probably temporarily, back-up when the primary source fails. And, as ever, keep a sharp lookout by all means available! Electronic navigation, especially space-based, has enhanced many human activities and is to be welcomed!

Does IAIN have a strong Asian membership?

We do indeed. Japan, South Korea, and China have been members for some years and play a full part in IAIN proceedings. North Korea has joined recently. There do not appear to be institutes of navigation in other Asian countries. However we would encourage and can advise on the forming of institutes.

The essential criteria are membership of an institute open to all and a constitution that embraces all forms of navigation. Too many people still cling to the ancient notion that navigation concerns ships and mariners when in fact it involves transport over land, in the air, and in space. Some newer members have difficulty in bringing these different modes into one institution or conference, even though GNSS is increasingly common to them all!

Which direction is the GNSS technology moving?

Undoubtedly towards greater accuracy, integrity, and compatibility between the various systems; this is a most welcome development. Chips already exist that will process GPS/GLONASS/Galileo together. It never ceases to surprise me what new uses or applications are being made of GNSS.

What are the main emerging areas for GNSS technology?

Whilst all applications would like to see more satellites, the areas of explosive growth are on the land – vehicle and pedestrian. It is these users who need the benefit of more satellites and hence will be using more than one constellation. Interestingly, it is also on land that integrity is becoming more in demand, even at a basic level, with the imminence of insurance premiums calculated by the mile (already started by Norwich Union) and road user charging (under serious consideration in several countries). Railways are also keen on GNSS to get more trains on the tracks, where continuity and integrity are vital. By and large the sea and air are pretty happy with what they have but will take advantage of GNSS improvements.

Do you feel that there are issues that need to be addressed to accelerate the growth of this technology?

There is the underlying tricky situation arising from the difference of the provision of a free GPS service to users, and the planned charges by Galileo for users of certain services.

This may well hamper the growth of Galileo for financial reasons. There are also political issues that can arise, even between co-operating nations which have the potential to delay progress.

How do you see the emergence of Galileo?

Undoubtedly, I see it as a complement, as well as indeed a compliment! The addition of another constellation will do much to enhance the overall value of GNSS to many users around the world. Galileo, as a project, has also done much to stimulate the whole arena of satellite navigation.

I have also been impressed by the willingness of existing GNSS system providers, especially GPS, to co-operate with Galileo in achieving compatibility with the emerging new system.

GEODETIC COMMENTARY

Real Geodetic Differences from 1880 to Present Year

Everest Ellipsoid	-	Semi-major Axis "a1880" is smaller** by about 830 m as compared to "a1980"
North Pole	-	NP1880 is about 15 m off from NP2007
Zero Longitude	-	SOI does not want to disclose the difference between λ1880 and λ (or Reference Meridian) of ITRF2000 (97.0)
Geodetic Latitude	-	ϕ1880 has changed by about 16 m from ϕ 2007.

***Note: The 1880 value of "a" does have an adverse impact on country's total area thanks to the best-fitting Everest Ellipsoid (SOI geodesists must be aware of this real effect).*

Muneendra Kumar, Ph.D.

The ignored dimension

Issues pertaining to forest management in India

J B LAL

Sustainability is the key issue in forest management, be it India, or any other part of the globe. Unfortunately, so far, no scientifically sound and operational definition of Sustainability has been evolved for universal application in forest management. Nevertheless, it may be said on an empirical basis that sustainable forest management lies in attaining three basic goals: first, maintaining the stability of the physical environment, secondly, maintaining, and if necessary increasing, the biological productivity of the resource, and thirdly, establishing equity in distribution of qualitative and quantitative benefits generated by the resource in the society dependent on it. The goals are to be attained not at any chosen point of time, but in perpetuity. Sustainable forest management is a multidimensional process. The major dimensions of the process are: ecological, silvicultural, technical (including the disciplines of genetics and biotechnology), socio-economic, and institutional. All the dimensions are equally important and neglect of any can mar the Sustainability of the process.

Goal-Dimension Matrix

If we considered the goals and dimensions of forest management together, we obtain the following matrix:

Goals | Stability | Productivity | Equity **Dimensions**
Ecological
Silvicultural
Technical
Socio-economic
Institutional

Perhaps, sustainable forest management would mean that all the three goals, and all the four

dimensions are in proper focus, and in the management process, no box in the matrix given above contains a negative value (Lal 1995).

Indian Forestry---- The Ignored Dimension

The tragedy in the Indian forestry has been that at any given point of time only one dimension of management was emphasized. If it was silvicultural till nineteen-sixties, it was socio-economic in nineteen-seventies, ecological in nineteen-eighties, and institutional in nineteen-nineties. The technical dimension was by and large ignored. There have been little or no technical innovations either in pre-harvesting (including management planning), or in post-harvesting (including monitoring and evaluation) forestry processes. Technical improvement with regard to harvesting, storage, and processing of non-wood forest products (NWFPs) has been little attended to. Nor has technical dimension been prominent in biodiversity conservation in general, and wild-life protection in particular. The situation in regard to identifications of goals has been rather nebulous. Till nineteen-sixties, the goal was distinctly none of the three. The goal was rather the earning of the maximum revenue for the state. In nineteen-seventies, the goal shifted towards producing greater quantities of commercial wood. In nineteen-eighties maintaining the ecological stability came to be identified as the predominant goal. In nineteen-nineties, the goal has been progressively shifting towards "equity" in social environment.

Identifying Objectives

Planned human activities are normally governed by the hierarchy of 'values', 'goals', and objectives'. Values, the abstract ideas that guide the thinking and action of society determine goals, the specific situations in relation to various activities that the society wishes to attain. Goals in turn determine objectives, the well specified targets, the activities aim at.

Technical dimension, though of not great relevance in the 'equity' goal, is great significance in relation to other two goals of sustainable forestry, viz., 'stability and productivity' of the physical environment. Objectives comprising the two goals with regard to which technological innovations or reorientation appear to be necessary in the Indian forestry may be identified as follows:

- forest cover monitoring,
- collection of physical, biological, and socio-economic data from ground, air and/ or space, and conversion of data into maps or information for management planning,
- simulation of forest ecosystems to foresee the effects of various human interventions,
- conservation of species diversity,
- conservation of genetic diversity,
- qualitative and quantitative improvement in production of wood and non-wood forest products,
- harvesting systems which do little damage to residual crop,
- regeneration of harvested areas,
- wood preservation,
- storage and processing of non-wood forest products.

Technical options

The foremost necessity in sustainable forest management is effective monitoring or forest cover not only in regard to crown density, but also in regard to structure and composition of the crop. Though presently in India satellite data is being used to prepare a biennial report on the status of forest, it gives information only on crown density, despite digital interpretation of imagery. To obtain information on composition and structure of the crop, small scale aerial photography is more useful. But in a large country like India with a forest cover of nearly 65 million hectares, it is not an economic proposition, and air-borne video recording would be more economical and useful for areas of immediate silvicultural concern. Nevertheless for obtaining forest cover situation at the country level there is no substitute for satellite imagery. Satellite imagery is also significantly useful in land use classification, estimation of growing stock, assessment of fire or pest damage, and in seeking information in regard to land degradation. As a matter of fact, it may be said without fear of exaggeration that availability of remotely sensed data has led to a holistic approach in forest management.

'Forest management plans', or 'working plans' are a basic requirement for sustainable forestry. The plans ensure continuity and objectivity in forest management. Preparation of a good working plan needs good information and a good decision support system. The technologies of remote sensing provide good, i.e., accurate, up-to-date and comprehensive information, and good geographical information systems (GIS) decision support.

The application of GIS in the preparation of working plans is only recent and limited in India. And, though India has made good use of satellite imagery, and to some extent of aerial photographs, it has not kept up with other advances in remote sensing technologies which might improve the quality of working plans.

We mentioned the possible use of air-borne video recording earlier. Use of air-borne lidar system for estimation of tree heights, and stand volumes (Nilsson 1996) is another example.

For maintaining ecological balance it is necessary that species diversity, and within species diversity, genetic variation, is maintained. It is relatively easy to monitor species diversity, but the monitoring of genetic variation needs the use of advanced technologies, such as DNA or isozyme anlysis by electrophoresis. An effective monitoring of genetic variation would help in improving silvicultural practices. A lot has to be done in India in regard to the monitoring of genetic variation.

In dense wet evergreen forests, saving the residual crop from much damage is one of the major concerns in adopting a silvicultural system as well as in selecting harvesting techniques. Damage to residual crop has not only economic, but also ecological implications. It may result in permanent loss of some species, or may reduce within species diversity. These losses might occur also from faulty design of extraction roads. Economics and operational feasibility of technologies, such as heli-logging and computer aided road designing, needs to be examined in the Indian context.

One of the major causes of deforestation in India ----- which is presently estimated by Forest Survey of India at 270,000 ha (FSI 1997), is the big gap between supply and demand of firewood, which happens to be the biggest source of domestic energy in the rural India. The demand of firewood exceeded supplies by over 100 million tones in 1987 itself (Lal 1992). The gap cannot by bridged by merely attempting to increase the production as land is a limited resource. Demand is also to be managed. The way firewood is presently used in the rural India, only 5-10 % thermal efficiency is attained (Lal 1992). The efficiency in use is to be increased manifold…maybe by use of more efficient stoves.

There is a gap of over 15 million cu. m. in demand and supply of industrial wood (Lal 1992). And though accurate estimates of demand and supply of non-wood forest products have not been made, it is believed that supply fails to meet demand not because of short production, but because of wastage in transport, storage, and processing of products. Use of technologies which save waste of wood and NWFPs in transport, storage, and processing would go a long way in bridging the gap between demand and supply.

Conclusion

Of major concern in Indian forestry is qualitative and quantitative improvement in wood production while maintaining the existing species richness and genetic variation in its forests. Great technological advancements are needed to meet these objectives. Indeed, the fundamental equation, Phenotype =Genotype + Environment, Needs to be extended to, Supertype = Phenotype + Technology.

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Trends in GNSS/INS integrated navigation technology

GNSS/INS integrated systems will benefit from deep integration architecture and AI technology

HE XIAOFENG, HU XIAOPING, WU MEIPING

Global Navigation Satellite System (GNSS) consists of GPS, GLONASS and Galileo which is still under construction by the European Union. GPS is the most widespread GNSS in the world and applies successfully in so many fields such as positioning, navigation, geodesy, mapping, timing and so on. However, GLONASS has not done its work well for about ten years because of lack of funds. In summer of 2006, Russia's GLONASS program continued its comeback and will have a full 24-satellite constellation by the end of 2009. Notably, China has a regional RDSS system using three geostationary satellites since 2000.

INS is a self-contained positioning and attitude device. In other words, it meets the all-environment requirement. The primary advantage of using INS is that velocity and position of the vehicle can be provided with abundant dynamic information and excellent short term performance. The main shortcoming is that the INS accuracy degrades greatly over time.

There is a strong possibility that a GNSS/INS integrated navigation system has superior performance in comparison with either a stand-alone GNSS or INS because of their complementary operational characteristics. Since 1980s, researchers have begun to investigate GPS/INS integrated navigation technology and the experimental results showed that GPS/INS integrated systems can efficiently improve the navigation performance. With the development and application of low-cost inertial measurement unit (IMU) and GNSS receiver, GNSS/INS technology has become one of the most popular methods of navigation for users worldwide.

On the one hand, the low-cost IMU, especially MEMS IMU, means low accuracy and low performance. It is hard to be directly usable as sole navigation systems because of their large random errors. On the other hand, navigation accuracy and integrity of GNSS will be degraded in the presence of radio frequency interference, hostile jamming and high dynamical situations in the so-called navigation war which was brought forward formally by USA in 1997. Aiming at these problems, researchers have recently focused their attention on deep integration and intelligent integration. These two methods will improve the robustness and precision of the integrated system greatly. Accordingly, researchers attach more importance to these two methods which are regarded as the trends in GNSS/INS integrated navigation technology.

Trend: Deeply integrated navigation

There are three generic functional architectures for GNSS/INS integration, that is, loosely, tightly and deeply (also named ultra-tightly) integrated mode. Traditionally, most GNSS/INS hybrid systems have been mechanized using loose integration or tight integration. Loosely integrated mode is the easiest and simplest approach because it is based on the independence of the GNSS and INS navigation functions. Although it provides some tolerance to failures of subsystem components, loosely integrated mode can not work when GNSS receiver doesn't track and lock at least four satellites at the same time. Tightly integrated mode where a GNSS receiver is not regarded as a navigation subsystem but as a sensor that provides pseudo-range (PR) and delta pseudo-range (DPR) was proposed to overcome the shortcomings of loose integration. This kind of mode benefits from GNSS measurement updates even if there are less than four satellites available for a complete GNSS navigation solution. It also reduces the complexity of the integrated filter due to lesser correlation of the integration variables (PR, DPR). However, tight integration is difficult to meet the demands of anti-jamming and high dynamical situations.

Designers have conceived of the deeply integrated mode which has higher performance than loosely integrated and tightly integrated mode. Figure 1[1] shows GNSS/INS architectures: loosely integrated mode, tightly integrated mode and deeply integrated mode. For deeply integrated mode, the GNSS measurements I (inphase) and Q (quadrature) from the GNSS correlator are integrated with the INS measurements. As shown in figure 1, one of the key techniques in the deep integration is the integration of INS derived Doppler feedback to the carrier tracking loops.

The deeply integrated mode provides the following manifold advantages:

1) Jamming to signal (j/s) ratio improvement
   Outputs of the deeply integrated filter are fed back into the tracking loops and used to control the code and carrier replica signals for each satellite channel[2]. A closed-loop comes into being and remains in lock even at low input signal-to-noise ratios

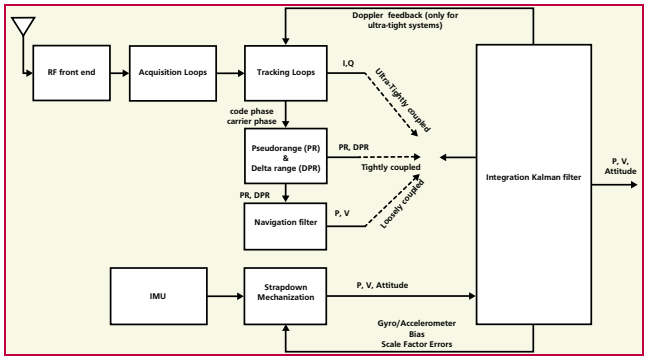

Fig.1 GNSS/INS architectures: loosely, tightly and deeply integrated mode

when aided by MEMS IMU.

In principle, the antijam of GPS receiver is about 32dB[3]. As shown in Figure 2, GPS receiver can't trace the signal well when there is a 0.1W jammer only 10km far away. Antijam improvements in deeply integrated mode relative to non-inertial-aided loop are 11dB. That was evaluated over a realistic precision guided munition (PGM) scenario in the presence of broadband jamming [2].

2) Improving system accuracy
Firstly, the accuracy of the raw GNSS measurements is increased due to lower tracking loop bandwidths aided by inertial data in deeply integrated mode. Secondly, errors of INS, mainly gyros/ accelerometers bias and scale factor errors, is calibrated periodically by integrated filter outputs. Thirdly, the integrated filter (usually kalman filter) is an optimal fusion including GNSS signal tracking loops and correlators which are contained in loosely and tightly integrated mode.
3) High dynamic performance
Inertial data provide the dynamic reference trajectory for the GNSS signal integration inside the receiver's correlators, which results in 'dynamic-free'[4] GPS signals that are sent to the tracking loops facilitating a significant reduction in the carrier tracking loop bandwidth, hence providing accurate carrier and code phase measurements.

The standalone GPS receiver uses a 2nd order carrier-tracking loop with a loop bandwidth of about 12 to 18Hz. However, deeply integrated system also adopting a 2nd order carrier-tracking loop the bandwidth can be reduced to 3Hz. That means that deep integration can work well in high dynamic environment.

Good technology can lead to perfect productions. Hereby, a guidance, navigation and control flight management unit which was housed in a small, light weight, low power package based on deep integration and MEMS IMU was tested successfully for the challenging requirements of modern tactical applications[5, 6].

Trend: Intelligent integrated navigation

The kalman filter is the most popular estimation tool for GNSS/INS integration because it is optimal in theory. However, in fact, real system can't satisfy all requirements of KF, such as supposed Gauss white noise, ideal dynamics model, and none error linearization. Furthermore, the more widely low cost IMU is adopted, the more obvious the limitations of KF become.

Nevertheless, Artificial Intelligence (AI) is a powerful tool for solving nonlinear problems that involve mapping input data to output data without any prior knowledge about the mathematical process involved. All kinds of conceptual intelligent navigator combining AI techniques were put forward to overcome the demerits of KF and improve the accuracy and reliability of the integrated systems.

In recent years, there have been some successful AI methods applied to GNSS/INS integration. Two artificial neural networks (ANN)-based INS/DGPS integration schemes for vehicular navigation were developed with a conjugate gradient-based training algorithm[7]. A new method is presented to improve the MEMS IMU/GPS performance using fuzzy modeling[8]. The GNSS/INS integration architecture using ANN which has the ability to mimic a human navigator, is capable of providing real time prediction and improve the performance during GNSS outages[9]. An Adaptive-Neuro-Fuzzy-inference-system (ANFIS)-KF model is used to correct the estimated KF outputs, which adopts Fuzzy-OLS algorithm for online ANFIS adaptive learning and impairs the influence of MEMS-IMU thermal variation by ANFIS[10]. Three AI-based methods, that is, a fuzzy logic rule-based system, a fuzzy expert vehicle dynamics identification system and a neural networks-based compass calibration algorithm, have been developed for GPS/MEMS INS integrated system[11].

We consider a case study that illustrates performance benefits of RDSS/INS integration[12]. In the case, the horizontal accuracy of RDSS positioning is 100 m and the minimum interval of positioning is 1.5 s because of active positioning mode. A tactical-grade IMU is used. Table 1 shows comparison of positioning error using five algorithms with same experimental data. BPNN aided KF

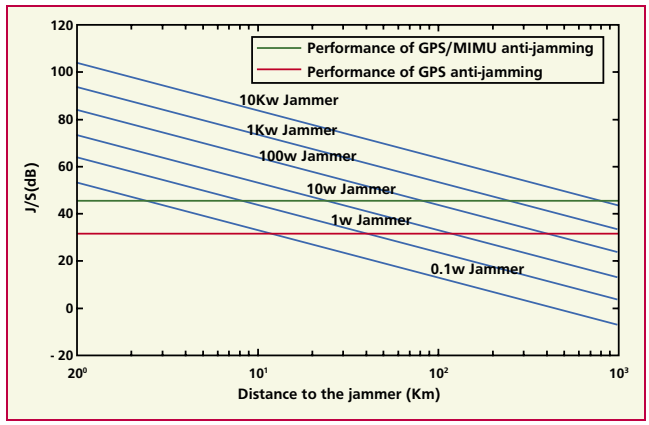

Fig.2 Performance of GPS/MIMU anti-jamming vs. GPS anti-jamming

has a best position accuracy. BPNN algorithm is also quite good. KF based on fuzzy inference is a little better than Sage-Husa adaptive KF. This indicates that algorithms with AI techniques improve positioning accuracy.

Conclusion

It can be seen from the above analyses that GNSS/INS integrated systems will benefit from deep integration architecture and AI technology. Some instructive researches have been set up recently, but it is just a beginning. Overall, we believe that the trends of deep integration and intelligent integration would be referred clearly as one of the most important directions during the wide applications of the integrated systems.

As fabrication techniques of MEMS sensors develop increasingly, some manufacturers foresee that the gyro bias error of a 2 in3-sized MEMS-based IMU will be achieved to 0.010/h by 2010[13]. In addition, the low cost, lightweight, and high G of MEMS sensors are the driving factors in more and more applications. Integration involving deep integrated mode and AI techniques should be made more feasible and attractive. Based on this, a low-cost attitude determination GNSS/MEMS INS integrated navigation system is likely to be designed.

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Table 1 Comparison of positioning error in RDSS/INS integrated navigation system

Algorithm	Position error /m		
	North	East	$\sqrt{North^2+East^2}$
1 KF based on velocity feedback	47.91	26.44	54.72
2 Sage-Husa adaptive KF	30.35	19.04	35.83
3 KF based on fuzzy inference	28.64	17.94	33.79
4 BP Neural Network	1.39	1.58	2.10
5 BP Neural Network aided KF	0.11	0.13	0.17

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Beyond mapping

Integration of varied information in GIS environment is not simple but complex and challenging

Brig P N Koul

Over the years topographic mapping generally involved acquisition of data related to the features of the earth, its environs of user's interest and its graphic depiction on a suitable media, generally paper, ensuring that the accuracy specifications, which depend upon the type of end product, are strictly adhered to.

The tremendous development in the field of computer technology, mainly during the last two decades, has lead to 'Data Explosion' wherein powerful computer systems have been developed and are now available and more so on desktops/laptops with latest operating systems and efficient software modules. This 'Data Explosion' has warranted development of versatile data processing and creative information systems which in turn have set in new trends in the generation and updation of Digital Cartographic Databases (DCDBs). The new trends in computer systems in general, and photogrammetric systems in particular, have forced a transition from traditional mapping to 'Mape-matics' i.e., maps as data, maps as numbers, in consequence to which the mapping agencies all over the world have taken up conversion of analogue map-data to digital form and its updation using digital photogrammetric techniques.

Beyond mapping-generation of DCDBs

Conventional topographic maps possess wealth of information which represents the spatial variation of the terrain. Despite being the models of spatial environment, the maps have limited utility in the context of manipulation of the data because of its non-digital form. On the other hand, digital cartographic databases (DCDBs) provide flexibility to relate and integrate data from varied data sources which has multifold advantages. This has set in new trends and has lead to the concept of integration of varied information under the umbrella of 'Geomatics' mainly to support integrated land resources management which is the prime requirement for sustainable growth and infrastructural development.

Geomatics integrates various scientific disciplines which pertain to acquisition, organization, management, archival, infrastructure, standardization, and dissemination of the data. Apparently traditional map making and geomatics have some similarities but practically many differences. In the geomatic environment, the complex integration of spatial and non-spatial data can be accomplished comparatively with ease and efficiency provided special care is taken while planning and generation of DCDBs, which amongst other things include, adherence to data accuracy specifications, an adequate choice of data structure, an optimum data model, a workable data exchange format, an efficient data storage system and a workable dissemination policy keeping in view the futuristic requirements.

Integration and interaction of a variety of databases is a crucial aspect and is complex in nature. It is best supported by Geographic Information System (GIS) which deals with the integration of spatial and non-spatial data from varied data source. GIS facilitates capturing, storing, checking, integrating, manipulating, analyzing, and displaying of data which is spatially referenced to the earth. It enables provisions of need-based information to the users for an efficient decision making process.

The advent of Global Positioning System (GPS) technology has added another dimension to the concept of geomatics. It enables near real time response in navigation and provision of ground control points by using the techniques of satellite tracking. India should be prepared to have alternatives, should the GPS signals be denied to us in any future crisis.

Data updation

The mapping agencies at present are not only confronted with the problem of generating the cost effective digital databases, but the basic need is to maintain and update the databases to make them more meaningful from the users' point of view. The present workshop may, therefore, be a step forward in the right direction.

The necessity of 3D topographic databases had already been projected by a number of users and this requirement may necessitate the generation of 3D databases on Analytical Plotters or/and Soft copy Photogrammeric Systems using aerial photography as the data source in combination with stereo imageries. To achieve this task, which obviously is not simple, our data procedures have to take up stereo digitization on a mass scale using the latest high and low end digital photogrammetric systems in combination. The linear details like roads, water-bodies, embankments, canals, forest limits etc. can be interpreted with ease and stereo digitized as per the pre-determined data structure. The data updation can be accomplished to an appreciable extent using stereo imageries in combination with the large scale photographs.

Some first hand experiences on data updation

Spatial data updation using stereo spot imageries (1993-1994)

a. Keeping the trends in photogrammetry in view, we, in Digital Mapping Centre, Dehradun, had taken up Experimental Test Programme in the year 1993-94 and carried out the feasibility study with the clear aim of evolving a technique for cost effective speedy updation of DCDBs. The technique, analysis, results, and methodology for the updation of DCDBs using SPOT stereo imageries (10m resolution) in combination with aerial photography were worked out. In this test programme, in depth studies up to the stage of checking of the ground truth was carried out for the test area.

b. The broader aim of the test programme was:

(i) To identify the limits up to which stereo imageries can be used to detect the change in 1:50K maps if used in isolation.

(ii) To interpret the contrast in the imagery in places where it is not possible to interpret details due to limited resolution.

(iii) To analyze if reference to large scale photographs can help in furthering the data interpretation/updation.

(iv) To carry out in depth evaluation in respect of the test area including the stage of verification of ground truth and conclude results.

c. During the feasibility study, it was observed that in one of the sheets where large scale photography was available, the change in contrast could be fully exploited by referring to the photographs. This was found to be of immense help and furthered the capture of additional data to a great extent. This data was also evaluated by subjecting the products to 'Ground Truth'.

Experimental test programme using new generation satellite spot-v stereo imageries

a. We have also taken up an experimental test programme on a high ended digital photogrammetric system for mapping 'Virgin Areas', using new generation satellite SPOT-V Stereo imagery, without ground control points.

b. The stereo imagery has a resolution of 5m in panchromatic mode. An effective resolution of 2.5 metres is obtained by sampling with the supermode process (THR on two digital channels). The presence of on board 'Star Sensor' which works in tandem with DORIS enables precise satellite attitude and the star tracker data gives the position. The experiment has given encouraging results.

Issues related to data updation

Three distinct problems specific to map updation using satellite stereo imagery in photogrammetric environment are:

a) Need for thorough comparison with existing map or cartographic database.

b) Change detection.
c) Interpretation of new features for stereo digitization.
d) Deletion of old features to the extent necessary.
e) Accommodation of errors in old maps.

Even the simplest revision process is sufficient to indicate the difficulties not normally associated with new map making. Discrepancies in respect to some features may come up between the existing map and the data captured by stereo-imagery or aerial photography which may not be attributed to any change. If confirmed that the new detail cannot be made to fit the old details, it becomes necessary to place the new detail with best approximation and, in most of the cases, the accuracy of the end product may still be within map specification accuracy limits.

A proper confidence limit has to be developed by the operators and propagated by way of need based training so as to enable them to capture the desired data after deliberate comparison between the existing map/digital files, the stereo-imagery, and the aerial photographs. From our experience we have seen that proper exposure and in-house job training supplemented with product evaluation can be of immense help in this regard.

Issues in creation of DCDBs

In the prevailing 'Data/Information Explosion', various powerful computer systems are available at the doorstep of user agencies who may be experiencing a blurred feeling because of the recent and inevitable transition to digital technology. The feeling is rendered more uncomfortable because of the availability of variety of computer systems, arcane terminology, dense theory, intricate protocols, and impractical examples. Under this blurred environment there lies a guiding torch in the form of GIS, which facilitates organization and its application.

In GIS environment, a digital cartographic database is the nucleus surrounded by data processing and data analysis techniques which facilitate queries and analyses. Consequently, the design and management of a cartographic database is of utmost importance. Both these aspects have a major implication on DCDBs in geomatics environment and have compelled computer engineers and cartographers to focus their attention more on the database rather than graphic form or the artistic perception of graphics. Some of the major issues in the digital cartography in the present context are data integration, data standardization, quality control, and data storage or archival and data dissemination.

Data integration

Various data producing agencies produce data in their own formats. Problems are bound to arise during the course of integration of this variety of data with the cartographic database of Survey of India. The need of the hour is to work out a systematic data fusion methodology in the absence of which many users may resort to quick and non-standard solutions for various localized utilities with narrow aims. This may lead to practical problems at the stage of transference of plans to actions on ground. Such problems have been envisaged in the integration of cadastral information with Survey of India topographic map and also in the generation of image maps from satellite data and digital cartographic database (Dasgupta, 1994). The data fusion standard need to be worked out so that different data sets, based on their own datum, structure, formats, and projections can be efficiently matched.

Data standardisation

The salient requirements of data standardization of digital cartographic databases may include:

a) Standardization of technical terms related to topographic data.
b) Standardization of scales and projections with respect to their utilities and services.
c) Standardization of various data sources for generation and updation of digital cartographic databases so that data source conforms to the accuracy specifications.
d) Standardization of symbols and patterns and their cartographic attributes.
e) Standardization of text and its attributes.
f) Standardization of data structure, data encoding, and data exchange formats in such a way that it facilitates speedy data retrieval/exchange.
g) The feasibility to follow a single data exchange format with variety of information generated by various agencies. In such case, the 'think tanks' may have to decide whether standardization of a family of data exchange formats will be appropriate.
h) Standardization of relationship of spatial variables in order to enable efficient GIS analysis.
i) Standardization of data structure (vector, raster) and feasibility of considering dual structure in the same cartographic database by retaining/ maintaining non-intelligent information in raster mode such as, sand feature, scattered trees etc.
j) Standardization of datum needs serious viewing keeping the international status in view. Pros and cons have to be weighed since the proposition is not simple because of the efforts involved in adopting it considering the wide extent of our country.

Quality control

Under the current environment, many Govt./Non-Govt. agencies may be generating their own database from various data sources. All of them may not be following the basic standards of digital cartography which is likely to lead to wrong analysis in a GIS environment. This may eventually contribute to erroneous decision

making and catastrophic results in areas where accuracy specifications are of prime importance, such as defence, land use, road and railway networks, measurement analysis, planning and execution of development tasks etc. Under the circumstances standardization of quality control needs no emphasis.

The best thing available to a user could be a 'Quality-tag' for each database, with respect to accuracy specifications, after the databases go through quality checks. The quality control tests need to be realistic. The tests have to be standardized such that no non-standard database finds its way in the pipe line else it may integrate with other databases and consequently bring down their purity. This leads to the concept of 'Validation of Cartographic Databases' which is of prime importance.

Generation and quality control of Digital Elevation Models (DEM) needs a special mention. DEM is the mathematical representation of earth's terrain in the form of X, Y, Z triplets. An accurate DEM will faithfully depict the elevation related information of the earth. Foolproof validation techniques need to be worked out and standardized because DEM is prone to propagation of errors. If proper care is not taken prior to the delivery of the data and it's archival, the DEM data generated may not serve the purpose for which it was generated and the realization could be too late.

Data storage and archival

Data storage and its archival with respect to digital cartographic databases demands voluminous space. Adequate media needs to be identified as per the latest state of art available in international market for mass storage for large databases. Standardization with respect to design of inventory system, optimum storage and its foolproof security, number of copies, and storage in duplication at different locations to safeguard against natural calamities are some of the salient aspects which need standardization and implementation.

Data dissemination

The policy of data dissemination has to be standardized so that the data generated is available to genuine govt. and non-govt. users. This aspect has a special impact on the security of the data. This subject has been actively addressed by the concerned Govt agencies. As regards the non-restricted data, the procedures for supply of data needs standardization such that the data is available to the users else the whole exercise of data creation may not serve much purpose.

Conclusion

Integration of varied information in GIS environment is not simple but complex and challenging. Great responsibilities lie on the shoulders of cartographers, space scientists, computer engineers and administrators to ensure that they address the issues like data fusion, standardization, quality control of digital products etc. This will facilitate creation of meaningful cartographic database for generation of quality information which should be second to none in the world.

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Major P N Koul – Spatial data updation using stereo imageries, ISPRS workshop, Working Group IV/2, Institute of Remote Sensing, Anna University (Nov-Dec, 1995).

Brig P N Koul
Director, International Boundary Directorate, Survey of India, New Delhi, India

Abu Dhabi to introduce new road maintenance system

Abu Dhabi is preparing a unique Road and Bridge Asset Management System. The system would establish a satellite-aided geographical database by using the GPS. It will also feature an e-archives for road executive designs and an e-connection with other working systems. The system seeks to standardize the methods and costs of maintenance work of the 20, 000-km road network and 90 bridges in the emirates, according to an official at department for Municipalities and Agriculture. *www.khaleejtimes.com*

GPS to track deer at Guindy National Park

The Wildlife department of Guindy National Park will make extensive use of GPS to arrive at a near-accurate estimate of the spotted deer and the endangered blackbuck.

The census, which will be done by a 100-strong team, will also cover the adjoining IIT Madras campus. The data of last year's census has been sent to the WLI to create a nation-wide database and the results are still awaited. *www.hindu.com*

Ohio to study black duck decline

The Ohio state is using GPS technology to find out what's happening to the black duck. Which has been on the decline in Ohio and elsewhere, while other types of waterfowl are thriving. The state Division of Wildlife has fitted three of the birds with radio transmitters so their movements and breeding patterns can be tracked. *www.ohio.com*

GPS software promises hope for the disabled

Anette von Laffert, at the University of Applied Sciences in Hamburg, Germany tested an application developed by fellow students that adapts data from the Microsoft Virtual Earth Web site to create a system of detailed maps that chart and display common barriers for the disabled like steps and cobblestones. The software, tentatively dubbed Trailblazers, aims to give wheelchair users a barrier-free guide to the world, helping to save time, reduce frustration and broaden horizons. *www.iht.com*

Naverus system approved for Chinese airport

Navigation technology by Naverus Inc., USA that helps airplanes land at difficult airports has been instituted at Jiuzhaigou Airport located at an elevation of 11,311 feet. The "required navigation performance," or RNP technology, created by the Kent company, has also been instituted at two other Chinese airports. The technology guides airplanes with a combination of avionics equipment, autopilot and Global Positioning System signals. *www.naverus.com*

Trekker talking GPS system debuts

Traveleyes now provides its clients with HumanWare's Trekker Talking GPS system, which would blind people to move around and offer more autonomy and independence to travelers using Traveleyes by enabling them to enjoy the places they visit even more. *www.telematicsjournal.com*

Falcon launches Internet GPS

A new GPS systems by Falcon GPS Tracking, USA allows parents to monitor, supervise and provide guidance to their teens both behind the wheel and in their day-to-day lives. The system with internet tracking capability monitors the speed and direction of vehicles from home computer. *www.telematicsjournal.com*

New GPS range tracking system

Northrop Grumman Corporation, USA develops a newly certified GPS range tracking system for the Minuteman III Intercontinental Ballistic Missile (ICBM) as one of the two independent tracking systems required for range safety. The GMTS replaces the C-band transponders previously used to track the Minuteman III test launches from Vandenberg Air Force Base. As directed by the Air Force Space Command, the C-band tracking system is to be deactivated in FY 2007 for cost savings and modernization. *www.irconnect.com*

China restrains mapping by foreigners

A new regulation restricting surveying and mapping by foreigners will be implemented in China on March 1 2007. Foreign organizations and individuals who intend to engage in surveying and mapping must obtain approval from the central government and accept supervision from local governments, according to the regulation. The Chinese law on surveying and mapping states that foreigners must cooperate with a Chinese partner and the activities must not involve state secrets or jeopardize national security.

The results of the surveying and mapping are owned by China, and must not be taken and transmitted abroad without legal permission, according to the regulation. The number of foreigners conducting surveying and mapping in China is on the rise and many field projects have been carried out illegally, which is a threat to national security, said the Ministry of Land and Resources without mentioning the number of such cases.

According to the State Bureau of Survey and Mapping, foreigners who illegally survey, gather and publish geographical information on China will be severely punished. Chinese partners or translators will be fined if they fail to stop illegal mapping activities. *http://www.chinadaily.com.cn/china/2007-01/25/content_792976.htm*

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Hemisphere GPS Innovation Wins FinOvation Award

Hemisphere GPS has announced that the Outback S2 GPS guidance system has won a FinOvation Award by Farm Industry News. The Award recognizes the most innovative new products published in Farm Industry News during the past year. The guidance system combines Crescent® GPS Technology with a simple guidance interface. When combined with Outback eDrive and the new BaseLineHD, it provides the most affordable one-inch pass-to-pass automated steering system available.

Hemisphere GPS has also introduced centimeter-level accuracy through a Real-Time Kinematic (RTK) application for professionals working in precision agriculture, marine navigation, surveying and others. It also provides the same accuracy as dual-frequency RTK systems but at a fraction of the cost. *www.hemispheregps.com*

Intermap to provide 3D data for Microsoft's Virtual Earth

Intermap Technologies Corp. shall provide Microsoft with NEXTMap Britain digital elevation data for use within Microsoft's Virtual Earth platform. The agreement enables to create and deliver a Live Search Maps product powered by digital terrain model of Great Britain. *www.intermap.com*

Applanix introduces POSPac Air Software Version 4.4

Applanix has introduced POSPac AIR Version 4.4, the latest post-processing software used to extend the accuracy potential of the POS AV system. It maximizes data quality and optimize workflow from project planning through to project completion. *www.applanix.com*

Trimble introduces GNSS receiver for agriculture applications

Trimble has introduced a GNSS receiver for agricultural users—the AgGPS 442 GNSS receiver. It can track GLONASS and next-generation GPS L2C satellite signalsm which improves the farmers ability to work in tough GPS environments with faster initialization times, and provides for increased productivity and reduced downtime in the field. *www.trimble.com*

ArcGIS Server Code Challenge announced by ESRI

ESRI invites developers to share their creativity and expertise with the GIS developer community by submitting original code samples to the ArcGIS Server Code Challenge at www.esri.com/codechallenge. Developers will have an opportunity to review and vote for the top three entries based on creativity, applicability, and relevance of the code sample. *www.esri.com*

smallTRIP: New Ntrip-client(GSM/GPRS) with internal GPS receiver

The smallTRIP unit delivers correction data to GPS receivers through mobile Internet (GPRS) in the form of RTK or differential-GPS. Streams of correction data can be in many different formats (RTCM, CMR). It uses Ntrip protocol for communication with Ntrip casters or it can connect directly to a HTTP-stream from an Internet connected reference station. The unit is tested in Europe and the US on different Ntrip casters (GPS-Spider, GPSnet and GNCASTER) and with many different GPS-receivers. Another feature of the unit is GSM-modem connection to a modem-based reference station. *www.smalltouch.com*

Touchscreen chartplotters for international boaters

Garmin has announced the GPSMAP 5000 series of multifunction displays (MFDs) – super-bright touchscreen chartplotters having large waterproof (IPX7) super-bright 12.1-inch diagonal XGA color display. It makes navigating menus a snap because the "virtual buttons" change depending on the function – allowing boaters to intuitively see and select the information they want, while eliminating the clutter they don't. *www.garmin.com*

BrightEarth-Global natural colour mosaic released

ComputaMaps releases BrightEarth, a natural colour image mosaic covering 95% of the Earth's land surface at a resolution of 14.25m. The source is the orthorectified Landsat 7 imagery acquired between 1999 and 2002 for NASA's GeoCover programme. Using a proprietary algorithm, it has transformed the original false-color GeoCover imagery mosaics into a single color-balanced global mosaic with bright, vivid natural color that retains the high contrast detail of the original pan-sharpened source imagery. *www.computamaps.com*

ProSDK and ProPacks 1.1 released by PCI Geomatics

PCI Geomatics release new version of the ProPacks collection and the PCI Professional Software Development Kit (ProSDK), used for building highly automated and customized workflow solutions. It is a set of software components that address a particular application area, such as orthorectification or mosaicking, and extends the capabilities of the ProSDK called PCI Pluggable Functions (PPFs) representing PCI Geomatics' core technology. *www.pcigeomatics.com*

Sierra Atlantic signed as INPHO's distributor for India

INPHO has appointed Sierra Atlantic Software Services Ltd,

Hyderabad, for distributing INPHO's digital photogrammetric software suite in India. *www.inpho.de*

NAVTEQ launches Map Reporter

NAVTEQ has updated its popular online feedback tool and renamed it NAVTEQ Map Reporter. The updated system is now map-based, giving users who discover potential discrepancies an easier way to provide feedback by pinpointing the exact location of the concern for possible updating of the database. *www.navteq.com*

DVP-GS Version 6.2 released

DVP-GS has announced the release of Version 6.2 of its professional photogrammetry software. It offers new and improved functionality with increased productivity and a completely revamped Orthomosaic module. *www.dvp-gs.com*

NID and Autodesk to promote design education

The National Institute of Design (NID), India and Autodesk has signed an agreement helping student to develop CAD skills. Richard Jones, Vice President of Autodesk said that under the agreement students on all three campuses - Ahmedabad, Bangalore and Gandhinagar - will be equipped with the latest versions of Autodesk's design software such as Autodesk Inventor, AutoCAD Mechanical, AutoCAD electrical and ALIAS design tools. *www.gujaratglobal.com*

MapInfo Acquires Graphical Data Capture

MapInfo Corporation has acquired Graphical Data Capture, Ltd., (GDC), a London-based location intelligence provider and partner of MapInfo for the past 17 years. GDC develops applications and offers consulting services primarily to local and regional UK government authorities, in addition to utilities, financial services and insurance companies.

Leica Cyclone 5.6 new Capabilities to Laser Scanning

Leica Geosystems announces the release of Leica Cyclone 5.6 software. The new Surveying™ software version lets users take advantage of laser scanners for popular orthophoto and stakeout workflows for surveying and mapping. The software enables users to efficiently control Leica HDS scanners and process rich point cloud.

NovAtel Inc. Launches Latest GPS/GNSS Engine

NovAtel launches DL-V3 – a rugged, feature-rich enclosure housing NovAtel's GPS/GNSS OEMV-3 engine. It has features such as Bluetooth for wireless connectivity and Ethernet for remote network access, as well as a removable Compact Flash card for data security and portability. It is also capable of tracking both GPS and GLONASS, and future GPS L5, signals. It delivers sub-meter positioning using OmniSTAR® or Canada-wide Differential Global Positioning System (CDGPS) L-Band correction services. Real-time Kinematic (RTK) solutions, including NovAtel's latest AdVance™ technology

Trimble Acquires INPHO GmbH

Trimble has acquired INPHO GmbH in an all-cash transaction. INPHO has a large customer base of more than 1,000 users in over 100 countries.Its products are used by service companies offering geospatial data collection by photogrammetry and Lidar as well as state authorities involved in supplying geospatial information.

TopoSys North America Inc. founded

TopoSys GmbH, Germany, has founded it North American subsidiary in Denver, Colorado, which would serves as a sales and support center for TopoSys Lidar systems in North America. *www.toposys.com*

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

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NASA to use RFID for spacecraft part tracking

Intermec, USA has announced a cooperative research effort with NASA George C. Marshall Space Flight Center to investigate new automatic identification tracking (AIT) technologies, to qualify machine-readable symbol markings and RFID devices for use on space-borne vehicles. Intermec will evaluate markings that have been exposed to low earth orbit environments during the third and fourth Materials International Space Station Experiment (MISSE) missions, and will also prepare additional marked samples and soft and rigid RFID tags to be included in MISSE 6, scheduled for July 2007. *www.usingrfid.com*

ScottishPower invests in ESRI-based mobile GIS system

ESRI has been awarded by ScottishPower plc, Glasgow, Scotland, a contract valued at £750,000 to ESRI (UK) Ltd. to provide a mobile GIS. It will enable up to 800 engineers, working across 70,000 miles of ScottishPower's United Kingdom electricity networks, to access and record map-based information while in the field. The GIS will enhance the capabilities by giving field engineers immediate access to accurate information such as the location of cables and other remote equipment. *www.esri.com*

6110 Navigator with integrated GPS

Nokia, has introduced the new Nokia 6110 Navigator, a navigation-enabled mobile phone bringing together GPS and AGPS functionality with always-on mobile connectivity. It features full personal navigation experience with integrated maps, routing and navigation. *www.nokia.com*

Motorola launches T805 and T815 featuring MOTONAV

Motorola, USA has announced its new Phone-based Navigation System T805 and T815. The T805 uses Bluetooth wireless technology to add satellite navigation to a compatible Bluetooth enabled phone. *www.motorola.com*

CoPilot Live 7 mobile phone GPS navigation

ALK Technologies, USA unveiled CoPilot Live 7 GPS navigation for mobile phones and PDAs. Supporting Windows Mobile 6 devices it is simple and intuitive, new clearer 2D/3D map views, and compelling mobile data services. *http://media.netpr.pl*

Etisalat launches location based services

Etisalat, UAE has announced the launch of LBS which is now accessible by all Etisalat mobile customers across the UAE, without the need for subscription. This service will enable them to know their locations visually over the map and the location of places of interest around them. *http://business.maktoob.com*

Windows Mobile GPS phone assists farmers

Germany-based SatconSystem Ltd. is shipping a Windows Mobile 5-powered PDA/phone aimed at agricultural applications. It has built-in GPS and wireless connectivity, and includes a suite of specialized software intended to assist farmers with surveying, navigation, and tracking tasks. *www.windowsfordevices.com*

Mainnav intros Bluetooth-enabled MW-705 GPS watch

Mainnav, Taiwan is offering up a GPS wristwatch with built-in Bluetooth and a SiRF Star III LP chip. The device can track current position, operate as a standalone GPS receiver, and also handle heart-rate monitoring, speed and distance tracking, and sense the temperature whilst frolicking in the great outdoors. *www.engadget.com*

SiRF and Skyhook Wireless to deliver GPS-Wifi hybrid

SiRF Technology Holdings and Skyhook Wireless, Inc. has announced that SiRF has licensed the WPS to create a single positioning system for wireless carriers that combines the best of both GPS and Wi-Fi technologies. This system promises to boost the availability and adoption of location-based services. *www.skyhookwireless.com*

Global Locate announces A-GPS reference design

Global Locate Inc., USA announced the availability of an A-GPS reference design based on Freescale Semiconductor's popular i.MX31 applications processor and Hammerhead assisted GPS chip. It patented signal processing techniques and host-based architecture re-utilize existing resources in the i.MX31 applications processor resulting in significant cost reduction, sensitivity of -160dBm and position fix times as fast as one second. *www.globallocate.com*

Novatel Wireless launches EV-DO Rev. A ExpressCard

Novatel Wireless, Inc., announces the availability of the Novatel Wireless Rev. A ExpressCard for the Sprint Power Vision Network. It offers A-GPS location-based capability and higher data speeds. *home.businesswire.com*

EU releases Radio Frequency band for Ultrawideband UWB

A harmonising decision of the European Commission has been adopted outlining the mandatory conditions for the use of ultra-wideband (UWB) technology across the 27 member states of the EU. UWB

Galileo update

Galileo – the European Programme for Global Navigation Services for civil purposes is an initiative led by European Union. We provide regular updates to our readers on the Galileo programme.

Galileo contracts worth over €40 million awarded to GMV

GMV announced that it has recently signed 5 new Galileo contracts worth over €40 million (USD 51.8 million). These contracts involve the supply of key systems and also a significant participation in the engineering and design tasks of the complete system. GMV now is the fourth biggest European participation in the programme and the biggest Spanish participation.

GMV is developing some of the key program elements responsible for the system's final performance features, such as the OSPF, the veritable brain of the Galileo system, which calculates the precise position of the Galileo Satellites and synchronizes all the system clocks, and the IPF, responsible for calculating the integrity parameters that enable Galileo to be used for safety-critical applications. In the control segment GMV is developing the FDF, which calculates the satellites' operational position and attitude and generates the necessary maneuvers to keep the satellites within the pre-established orbit and antenna-pointing parameters at all times. *www.gmv.com*

u-blox to unveil new Galileo-ready GPS chip

u-blox AG, Switzerland, has unveiled u-blox 5, a GPS and Galileo-ready chip featuring an acquisition performance of less than one second, at the 3GSM World Congress in Barcelona, Spain. The new technology boasts an acquisition and tracking sensitivity of -160 dBm that enables indoor coverage, a 50-channel engine and a power consumption of less than 50 mW. Its energy efficiency and tracking sensitivity make it ideal for GPS-enabled mobile phones and other battery-operated portable devices that operate in difficult indoor environments like shopping malls, train stations and urban canyons. *www.u-blox.com*

Galileo Services goes international

Established in 2002, the Galileo Services association consists of key European players in the GNSS downstream industry. The GNSS market is global by nature, and Galileo Services continue to expand with new members from non-European countries. Canadian NovAtel, US-based JAVAD GNSS, dmedia System from Taiwan and SEIKO EPSON from Japan are now members of the non-profit association, whose objective is to foster development of technologies and pilot value-added services and applications for the future use of Galileo.

"Galileo is a global system and it is therefore important to be able to have a global view also when it comes to downstream applications and services" stated Mr. Gard Ueland, President of Kongsberg Seatex and Chairman of Galileo Services. "That motivated our decision last year to open the association also to non-European companies. New members and especially our new members from North-America and Asia are all valued supplements to the association." Since the association was opened for non-European members, Galileo Services has received requests for membership from all over the world from companies that want to join the leading representative of downstream industry towards the Galileo Programme. *www.galileo-services.org.*

is a radio technology which sends low energy pulses spread across a wide spread of frequencies enabling high data rate communications, imaging of objects through walls and high precision location tracking. Ubisense, Cambridge, England has developed an advanced real-time location system based on UWB technology. *www.ubisense.net*

Underground/indoor GPS repeater to ensure geo-location

A recent patent application is looking to implement a repeater system to ensure the best possible geo-location data regardless of surroundings. The GPS repeater system would require multiple antennae to be setup atop buildings and other obstructions, which would be wired to an indoor RF repeater system that directional receivers could tap into and it would reportedly amplify them as well to ensure a solid connection. *www.engadget.com*

Finding your location is big business

Finding location is big business and has been dominated by GPS. But another technology is available in Australia that allows standard mobile phones to be located using a technique called GSM triangulation developed by Sydney based wireless innovation company redcoal Pty Ltd which has just launched GSM location based services. *www.redcoal.com*

Vivo partners WaveMarket to launch family location service

Brazil's Vivo has partnered with US LBS company WaveMarket to launch a family location service, which will run over a BREW software platform.

It allows the addition of new features such as location-based alerts that automatically notify parents whenever a child enters or leaves a designated area like school or home helping them locate children, manage permission to leave school early, and receive alerts on the web or on an application on a mobile phone.

Positioning Indian Space Programme in the Position and Navigation Services

IRNSS (Indian Regional Navigation Satellite System) from ISRO to provide highly accurate position, velocity and time information in real time.

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Geospatial Intelligence Standards: Enabling a Common Vision

The National Geospatial-Intelligence Agency (NGA) has issued a new document that provides guidance and direction to develop an overall baseline for common geospatial standards used to share, manipulate, and exploit digital geospatial data. The document, "Geospatial Intelligence Standards: Enabling a Common Vision," outlines the standards that will be used in the National System for Geospatial-Intelligence (NSG). The NSG is the combination of technology, policies, capabilities, doctrine, activities, people, data and communities necessary to produce geospatial intelligence (GEOINT) in an integrated multi-intelligence, multi-domain environment. *www.nga.mil*

Swiss help for coherent land use policy

A group of international experts has called on the Swiss government to ensure a more coherent land use policy in the country. Their comments come at a time of increasing debate on urban sprawl in Switzerland, with opponents hoping to bring the matter to a nationwide vote. The report commissioned by the Swiss Spatial Development Office gathered together the views of five experts from neighbouring Germany, Austria and France, as well as the Netherlands and Britain. *www.swissinfo.org*

Concept of SDI in Russian Federation

This concept note, prepared by the GIS-Association, defines goals, objectives, scope, structure, fundamental principles and activities regarding establishment and development of spatial data infrastructure of the Russian Federation. The GIS-Association is an interregional community created to promote the geospatial technologies and services market. It has been active in Russia, the CIS countries and Baltic States since 1995. The main goal of the Association is to promote market relations in the geoinformatics sphere, which includes digital mapping, topography, and navigation and RS data usage in regional and corporate GIS projects.

3D city model for Delhi

The Department of Science & Technology, Survey of India (SOI) and the Ministry of Urban Development (MOUD), have come together to make the data based on 3D city model available to the city of Delhi. It will combined efforts to see that data starts flowing after nine months and for the National Capital Territory of Delhi, it is completed within three years. The project is estimated to cost over Rs. 100 crores (US$ 2 million), which would soon be recovered by way of enhanced revenue collection. *http://pib.nic.in*

Malaysia and Japan to develop flood hazard mapping

Malaysia and Japan shall develop a flood hazard mapping system which will enable the country to forecast the effects of global warming. Malaysia's Natural Resource and Environment Deputy Minister Datuk S. Sothinathan said the system will enable the government to predict the worst case scenario of flood disasters in 50 to 100 years due to climate change that had already taken its toll globally. *www.bernama.com.my*

Bengal govt orders land-mapping

The West Bengal government has appointed Mott MacDonald to determine the distribution of land in the state. West Bengal Industrial Development corporation has been assigned the task of monitoring the land mapping exercise. According to Ms Nandini Chakrovorty executive director at WBIDC "The land-mapping exercise will be carried out in two phases. In the first stage, to identify places which have roads, water, electricity and mineral resources suitable for setting up industries. In the second phase, intense study of the land and come up with suggestions on which areas in the state are suitable for setting up industries. *www.timesofindia.com*

NATMO to launch Golden Map Service

National Atlas and Thematic Mapping Organisation (NATMO) would map the entire country down to the village level using spatial technology through its Golden Map Service. The programme has been launched at the concluding ceremony of NATMO's golden jubilee on held recently. *www.hindu.com*

GIS labs in Afghanistan ministries

The Afghanistan Information Management Service (AIMS) has been facilitating the development of advanced GIS and mapping capability in Afghanistan, and therefore created 11 GIS labs within 11 government ministries and departments. They are able to print their own maps for planning and project implementation purposes and were chosen based upon their need for GIS capacity building and services.

GIS in Agriculture Division of Bangladesh Planning Commission

The Center for Environmental and Geographic Information Services (CEGIS), Ministry of Water Resources, Bangladesh shall be "Setting up GIS facilities in the Agricultural Division of the Planning Commission and e-Government Survey". Under the sub project, the Division will be enriched with the establishment of a GIS based Customized Application Software, comprising metadata, and a web-based Project Information Management System. *www.cegisbd.com/secretary.htm*

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Vietnam to launch its own remote sensing satellite by 2010

Vietnam plans to build it own remote sensing satellites in the next decade, a top space official has said. The Prime Minister of Vietnam had recently approved a programme for space technology research and applications that will last until 2020. *http://vietnamnews.vnagency.com.vn*

Brazil-Ukraine joint venture

An agreement between the two countries establishes that Brazil will open up its space base in Alcântara and Ukraine will provide its rocket launching technology. The objective is to enter the competition for the global satellite launching market, worth US$ 10 billion. *www.anba.com.br*

Emergency areas in Russia can be seen better from space now

In 2007, a broad-scale emergency situations space monitoring system started to operate in Russia. Starting in late 2006, Russian Ministry of Emergencies has been implementing a comprehensive program of upgrading the departmental system of emergencies monitoring from space. ScanEx Center has won a contract on the outfitting of regional emergency centers with universal space data reception ground stations. Specialists from the company put into operation two new UniScan ground stations in Siberian Regional Emergency Center in Krasnoyarsk and in Vologda Regional Emergency Center. *www.scanex.com*

China to launch "Haiyang-1B"

China will launch the country's second-generation oceanic survey satellite, "Haiyang-1B" (Ocean 1B), this April. It is the successor of "Haiyang-1A" (Ocean 1A), which was launched in 2002. The surveying ability of "Haiyang-1B" has been improved greatly from the first-generation model, and its data collection capacity has doubled. Both the satellites and the Earth system were designed domestically. *http://english.people.com.cn*

China launches fourth Beidou navigation satellite

China successfully launched a 'multi-purpose' navigation satellite into orbit. The satellite - Beidou (Big Dipper) - is China's fourth navigation experimental satellite in orbit. The previous three were sent in space on October 31, 2000; December 21, 2000 and May 25, 2003 respectively. *www.ecanadanow.com*

Satellite mapping initiative launched by US and Canada

The U.S. Geological Survey and Natural Resources Canada have launched a high-tech satellite mapping initiative that can better monitor changes in the combined land cover. Using infrared, radar relief and other remote sensing techniques, the partnership will produce integrated information that will help natural resource managers to better assess the health of landscapes, cross border wildland fire risks, changes in biodiversity and the effects of climate change on permafrost. *www.nrcan.gc.ca/media*

Satellite imagery helps decide crop insurance

The Central government had established the Agriculture Insurance Company of India for focused development of a crop insurance program, under the National Agriculture Insurance Scheme (NAIS).

In addition to the temperature and rainfall index, it has an innovative element of being able to calculate the crop vigor, or the health of the crop, while it is in the field with help of remote sensing. The company buys satellite pictures of areas from the NRSA and a consultant uses a specially designed index called Normalized Difference Vegetative Index (NDVI) to assess crop vigor. *www.indianexpress.com/story/20947.html*

Anti-satellite test not directed at any country

Chinese Foreign Minister Li Zhaoxing told India's External Affairs Minister Pranab Mukherjee that Beijing's January 11 anti-satellite test (ASAT) was not directed against any country. Mr. Li informed Mr. Mukherjee that ASAT was a technological and scientific endeavour. Beijing remained opposed to militarisation of outer space. *www.hindu.com*

Satellite killing test by China against international convention

India's space agency chief has slammed China for its anti-satellite missile test, terming the shooting down as one against international convention and said New Delhi should make efforts to exert pressure on Beijing not to undertake such strikes.

"They (China) should not have done that. It's against international convention. First of all, we are not supposed to weaponise the outer space", Chairman of Indian Space Research Organisation Mr. G Madhavan Nair, said here.

"Secondly, by killing a satellite, you create much more debris. Today about 8,000 objects are there in orbit. By blasting one satellite, you create another few hundred (objects)", he said. "That way, I don't know why they did that. It's not a right thing". *www.hindu.com*

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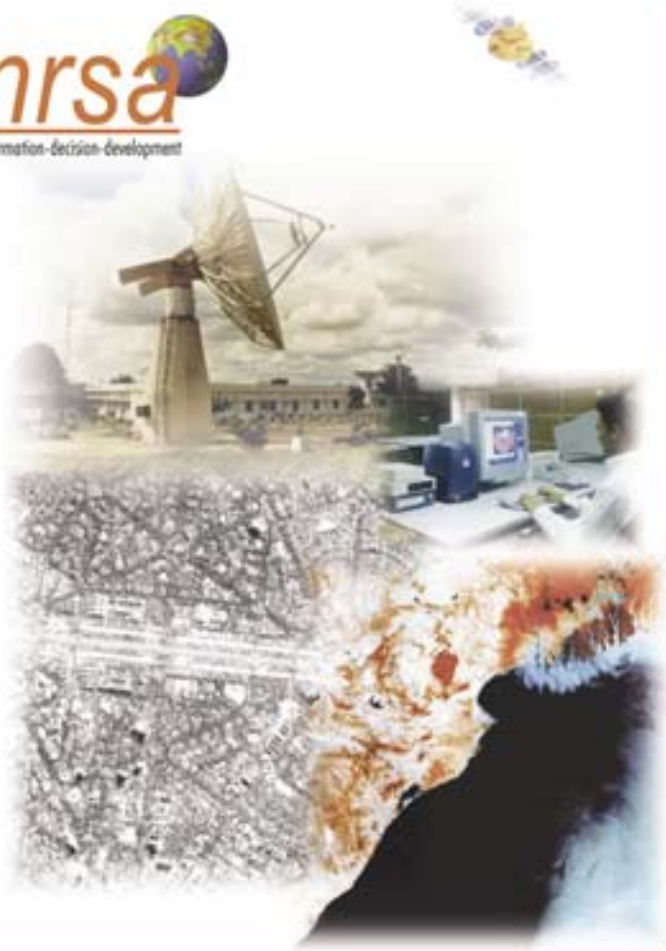

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4,800 Survey of India maps to be released into public domain

Some 1,600 Survey of India topographical sheets awaiting defence clearance would now be available for use according to the officials at Department of Science and Technology. Four hundred had been cleared, and by March-end all 4,800 SoI maps, many of them for the first time, would be available for the public domain.

"These maps are part of our 1:50,000 series. As many as 2,900 were part of the open series, but the rest were not meant for general viewing ever before. Now we can proceed with both—the 40 cities project as well as the 1:50000 series," said Major General M Gopal Rao, Surveyor General of India.

"We are now in business," added Dr R Siva Kumar, Head of NSDI. First, 40 major cities will be mapped on a scale of 1:1000 and in later phases the entire country will be covered. The NSDI network, explained Dr Kumar, will be able to superimpose all manner of data onto a digital map.

www.timesofindia.com

Institution of Surveyors, India announces:

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6-10 March, New Delhi
15-19 May, Andaman & Nicobar Islands
10-14 July, Shillong
21-25 August, Jammu
colbhat@yahoo.com

Spatial Data for Effective Land Management
10-12 October, Mumbai, India
colbhat@yahoo.com

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April 2007

63rd Annual Meeting, Featuring New Bio Navigation Workshops
April 23-25, 2007, Cambridge, MA
www.ion.org

2nd National GIS Symposium in Saudi Arabia
23-25April, 2007 Al-Khobar, Saudi Arabia
info@saudigis.org.
http://www.saudigis.org/

May 2007

TimeNav'07 - ENC-GNSS 07
29 May - 1 June 2007
Geneva International Conference Center,Switzerland

Spatial Sciences Institute Biennial International Conference
14-18 May, Hobart, Tasmania, Australia
www.ssc2007.com

Intergraph 2007
21-24 May, Nashville, Tennessee, USA
http://www.intergraph2007.com

International Conference on Integrated Navigation System
28-30 May, Saint Petersburg, Russia
elprib-onti@telros.net

5th International Symposium on Mobile Mapping Technology
28-31 May, Padova, Italy
naser@geomatics.ucalgary.ca

June 2007

Navigation Europe 2007
6-7 June 2007 in Amsterdam.
www.telematicsupdate.com/naveurope2007/

27th ESRI International User Conference
18-22 June San Diego, California USA
www.esri.com

TRANS-NAV 2007
20 to 22 June
Gdynia, Poland.
weintrit@am.gdynia.pl

Geoinformation Forum Japan
20-22 June, Pacifico Yokohama, Japan
geoforum@jsurvey.jp

July 2007

Cambridge Conference 2007
15-20 July Cambridge, UK
www.ordnancesurvey.co.uk/

Asia Oceania Geosciences Society30 July – 3 August, Bangkok, Thailand

August 2007

7th International Workshop of GIS
1-3 August Beijing, China
iwgis@lreis.ac.cn

XXIII ICA International Cartographic Conference
4-10 August, Moscow, Russia
info@icc2007.com.

GIS 14 Conference
14-15 August 2007
Vietnam

ISPRS Workshop on Updating Geo-spatial Databases with Imagery
28-29 August, Urumchi, Xinjiang, China
jjie@nsdi.gov.cn, jiangjie_263@263.net.

2nd Indonesian Geospatial Technology Exhibition
29 August - 1 September
Bakosurtanal; Jakarta
http://www.geospatial-exh.com/

September 2007

ION GNSS 2007
September 25-28, 2007, Ft. Worth, TX
www.ion.org

October 2007

36th Annual ILA Convention and Technical Symposium!
October 14-17, at the Embassy Suites Orlando International Drive Orlando, Florida, USA

Nav 07 - The Navigation Conference and Exhibition
30 Oct 2007 -01 Nov 2007
www.rin.org.uk
conference@rin.org.uk

9th South-East Asian Survey Congress
28 October - 2 November
Christchurch, New Zealand
http://www.surveyors.org.nz/user/

November 2007

International Symposium and Exhibition on Geoinformation & International Symposium on GPS/GNSS
05 - 07 Nov 2007
Johar Bahru, Malaysia

ISG/GNSS 2007
6-8 November, Kuala Lumpur, Malaysia
md.nor@fksg.utm.my

ACRS2007
November 12-16, 2007
Kuala Lumpur, Malaysia
http://www.macres.gov.my/acrs2007

WG I/6 Workshop on Remote Sensing Applications
13-16 November, Kuala Lumpur, Malaysia
mazlan@fksg.utm.my

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