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Intelligent navigator

Mapping the MALDIVES

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Articles






Columns

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Our sincere condolences to those that have suffered in the recent earthquake.

Bal Krishna, Editor
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The conceptual intelligent navigator

Readers may recall that in September issue authors gave an update on recent developments of alternative INS/GPS Integration schemes. The concluding part of the paper observes that given the fact that the incorporation of artificial intelligence to the navigation algorithm is new to the navigation community, it needs more extensive research to accelerate wider inclusion of such an idea to commercial products

Dr Kai-Wei Chiang and Dr Naser El-Sheimy

The goal of developing any intelligent machine is to mimic human behaviors and achieve certain goals that can not be fulfilled by adopting conventional methods [Cawsey, 1998].

According to Honavar and Uhr [1994], the intelligence can be defined as the ability to learn, understand and adapt. The human brain has the ability to learn adaptively in response to knowledge, experience and environments by a network of interconnected adaptive information processing elements that transform inputs to desired outputs [Principe et al, 2000]. In other words, the intelligence first requires the ability to transform the acquired sensory information or raw data to certain form of useful information which can be regarded as knowledge. In addition, it demands a continuous learning process to guarantee the accumulation of acquired knowledge. Thus, the conceptual intelligent navigator is expected to have the ability to learn and adapt.

	Sensory information	Knowledge
Contents	• Sensor output, result of data acquisition • raw signals or preprocessed • data is not an end product, nor does it directly provide answers to applications	• to 'deal with knowledge, it must be represented • knowledge and its representation are closely related • knowledge: facts, procedures heuristics that can be used to make inferences

Table 2: The comparison between sensory information and knowledge (After Honavar, V. and Uhr L,1994)

Learning is defined as a process of acquiring and memorizing new information, knowledge and experience [Cawsey, 1998]. The adaptation can be regarded as the ability of the information processing elements to change in a systematic manner and alter the nonlinear transformation between inputs and outputs. In other words, learning and adaptation are interpreted as the mechanization of knowledge evolution process. Therefore, the intelligence of human is derived and accumulated through continuous sensory data acquisition and knowledge evolution. Table 2 illustrates the comparison between sensory information and knowledge. In addition, Figure (2) depicts the process of adopting acquired sensory information to generate certain knowledge through human vision.

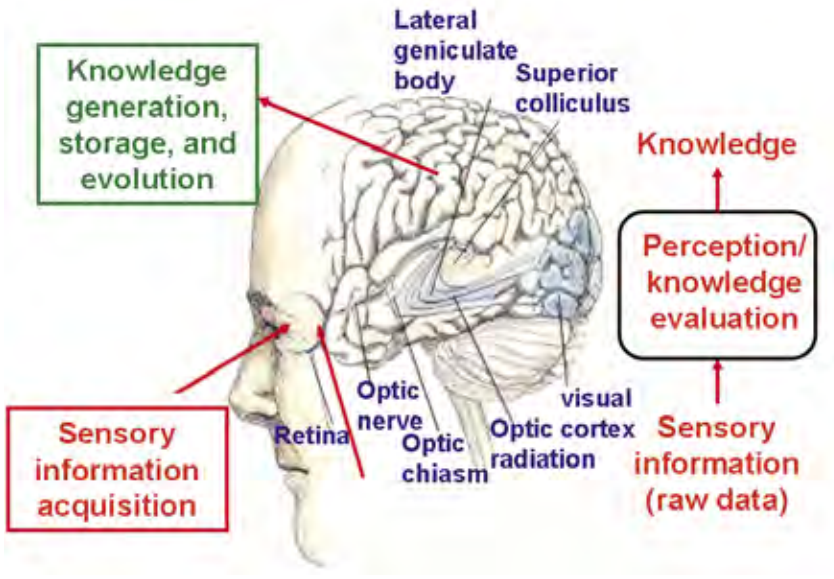

Figure 2: The process of knowledge via human vision (After Honavar, V. and Uhr L, 1994)

Being inspired by Figure (2) and Table 2, thus, three functional schemes of the knowledge evolution process of the conceptual intelligent navigator that fulfill the requirements of self-learning or adaptive learning can be identified, as shown in Figure (3).

As indicated in the Figure (3), to acquire the navigation knowledge

for further processing, Chiang [2004] proposed several ANNs based INS/GPS integration schemes that use Multi-layered

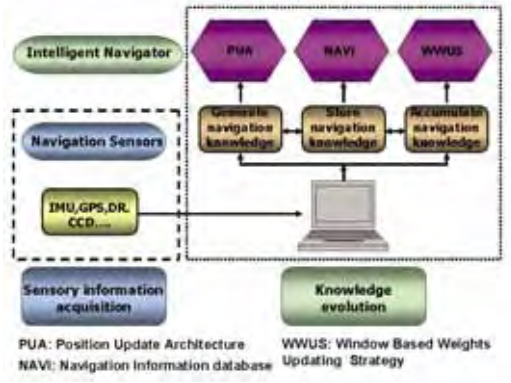

Figure 3: The functional schemes of the knowledge evolution process

Feed-forward Neural Networks (MFNNs). The MFNNs trained by the backpropagation algorithm is the most well-known and most common used neural network today.

The INS/GPS integration architecture implemented in this article is called the Position Update Architecture (PUA) which consists of a two layered feed-forward neural network. It integrates the data from INS and DGPS and mimics the dynamical model of the vehicle to generate navigation knowledge. Thus the latest acquired navigation knowledge can be applied to predict the vehicle's position during GPS outages in real time [Chiang and El-Sheimy, 2002].

The topology of PUA is illustrated on the left side of Figure (4). The input neurons receive the velocity at current epoch ($V_{INS}(t)$), azimuth at current epoch ($\varphi_{INS}(t)$) from INS mechanization. The number of hidden neurons is decided empirically and given in Table 3; see Chiang et al., [2003] for more details. The output neurons generate the two dimensional coordinate differences between two consecutive epochs in the local level frame ($\delta N(t)$, $\delta E(t)$). In addition, Figure (4) illustrates the system configuration and learning strategy of the PUA.

	Candidate hidden neuron number	Applied in this article	Linearity of hidden layer / output layer
PUA	N=10~200 (ΔN=10)	50	non-linear/ linear
Learning algorithm: Levenberg - Marquardt learning algorithm			

Table 3: The number of hidden neurons of PUA

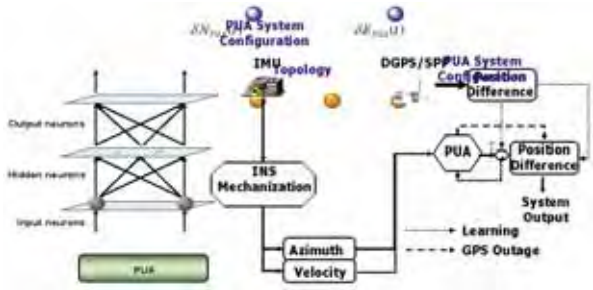

Figure 4: The topology and system architecture of PUA

The desired outputs ($\delta N_{GPS}(t)$, $\delta_{GPS}E(t)$) are provided by GPS during signal availability in either DGPS or SPP mode of operation.

As long as the GPS signals are available for more than 4 satellites, the learning process continues to reduce the estimation error in order to obtain optimal values of the NN parameters. Thus, the navigation knowledge can be learnt, stored and accumulated during the availability of the GPS signal. On the other hand, during GPS signal outages, the latest acquired navigation knowledge can be retrieved from the "brain" of the intelligent navigator to predict the position ($N_{PUA}(t)$, $E_{PUA}(t)$) in real time.

As indicated in Figure (3), the second step towards building the conceptual intelligent navigator is to store the learnt knowledge acquired in the previous section. As a result, a navigation information database (NAVi) that contains the acquired and learnt navigation knowledge

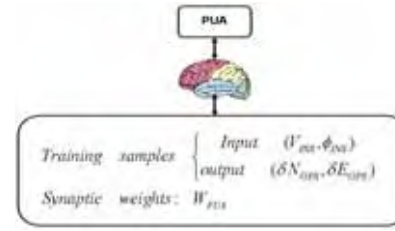

Figure 5: The content of NAVi (PUA)

can serve as the "brain" of the conceptual intelligent navigator, as shown in the Figure (5).

According to most of the NN related literatures, only the synaptic weights are interpreted as the learnt knowledge, however, Chiang [2004] suggested that the training samples that were applied during pervious learning processes should be stored and regarded as a part of the navigation knowledge to maintain the generalization capability of the proposed architecture after current or future learning process.

As indicated in Figure (3), the synaptic weights are the core components of the navigation knowledge; the final step towards building the conceptual intelligent navigator is to develop a strategy to accumulate the acquired navigation knowledge by updating the synaptic weights whenever the GPS signal is available. In the case of INS/GPS integration for navigation applications, it is required to track direction changes and mimic the motion dynamics utilizing the latest available INS and GPS data. In other words, the synaptic weights should be updated during the navigation process to adapt the network to the latest INS sensor errors and the latest dynamics condition whenever the GPS signal is available.

To implement such criterion, Chiang et al., [2004] proposed a window based weights updating strategy to utilize the synaptic weights obtained during the conventional off-line training procedure (or probably from previous navigation missions) and stored in the NAVi. This criterion utilizes the latest available navigation information provided by the GPS signal window to adapt the stored

Field test	Trajectory	Other information	Satellite availability
1	• Shape: L-shape • The duration: 3800 seconds	• Baseline:4km • Travel distance 32km • Data rate: 1 Hz	No natural GPS signal blockage or obstruction
2	• Shape: Circle/ Rectangular • The duration: 1900 seconds	• Baseline: 3km • Travel distance: 8.5 km • Data rate: 1	No natural GPS signal blockage or obstruction
3	• Shape: Complex trajectory • The duration: 1200 seconds	• Baseline:15km • Distance traveled: 15km • Data rate: 1 Hz	• Six natural GPS outage

Table 4: The information of different field tests

synaptic weights so that they can be applied to mimic the latest motion dynamic and INS sensor error.

Chiang et al., [2004] demonstrated the advantages of the proposed strategy in terms of the prediction accuracy during GPS signal blockages in real time mode. Since the ANNs training procedure takes time, updating the synaptic weights immediately at the latest available sample of a GPS signal before outage is difficult. However, the utilization of the proposed method can still provide reasonable prediction accuracy during GPS signal outages since it can utilize the latest acquired and learnt navigation knowledge to provide real time solutions.

Therefore, the conceptual intelligent navigator has the ability to guarantee the knowledge evolution through the continuous learning process during the availability of GPS signal. Comparing to the traditional navigator that uses Kalman filter algorithm, the proposed conceptual intelligent navigator demands more storage space to accumulate navigation knowledge. However, as the accumulation of the navigation knowledge makes the conceptual intelligent navigator different from the traditional navigator, it is the price to pay [Chiang, 2004].

Results and discussions

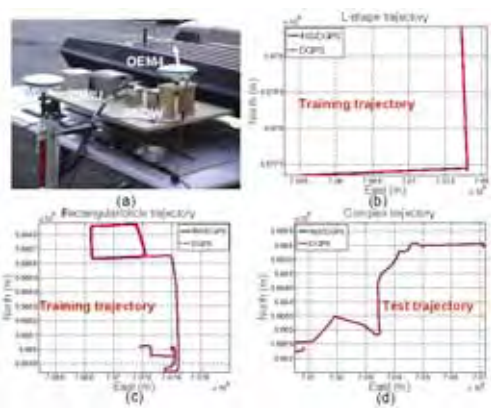

Figure 6: The picture of test van and trajectories

To evaluate the performance of the conceptual intelligent navigator, three field tests were conducted on October 2003 by the Mobile Multi-sensor Systems (MMSS) research Group of the University of Calgary. The tests were conducted in land vehicle environments using different INS/GPS integrated systems consisting of a navigation grade IMU (Honeywell CIMU), MEMS IMU (Crossbow AHRS-400 CC, XBOW), and two NovATel OEM-4 receivers. Figure (6a) shows the test van provided by Novatel Inc. and the set up of these IMU systems. Table 4 summarizes the basic information of those field tests. Figure (6b), Figure (6c) and Figure (6d) illustrate the trajectories of these field tests. The blue solid lines in these figures illustrate the trajectory generated by CIMU/ DGPS integrated solutions and the red dot lines show the trajectory generated by the DGPS solutions using carrier phase measurements.

The reference trajectories were generated by the CIMU/DGPS integrated system. The IMU and GPS measurements obtained through the first and second field tests using the above mentioned INS/DGPS integrated systems were applied to generate the stored navigation knowledge. After that, the third field test was used as the test trajectory.

To examine the difference between the conceptual intelligent navigator and the traditional navigator that consisted of a 15 state extended Kalman filter, Two short GPS outage scenarios (e.g., 30 seconds and 90 seconds) that have eight short GPS outages in each scenario (e.g. 6 natural and 2 simulated

	30 seconds						90 seconds					
	IN_E	IN_N	IN_T	KF_E	KF_N	KF_T	IN_E	IN_N	IN_T	KF_E	KF_N	KF_T
1	1.35	0.93	1.64	2.18	2.78	3.53	6.12	6.00	8.57	41.70	9.06	42.67
2	0.10	0.47	0.48	2.91	0.90	3.05	4.04	10.06	10.84	64.21	32.48	71.96
3	0.49	0.15	0.51	7.22	1.24	7.33	13.15	3.97	13.74	76.82	13.16	77.96
4	4.53	0.55	4.38	4.48	1.74	4.80	6.24	6.31	8.87	42.70	52.92	68.00
5	0.38	1.30	1.35	3.34	0.62	3.40	7.01	7.72	10.43	57.00	10.71	58.00
6	0.28	0.27	0.39	0.11	0.56	0.57	10.03	5.45	11.42	5.05	17.79	18.49
7	1.44	0.36	1.48	1.88	0.64	1.99	9.00	5.09	10.34	138.50	96.22	168.64
8	2.08	0.46	2.13	0.17	2.70	2.72	10.81	1.88	10.97	23.27	28.63	33.34

IN/KF_E: East channel RMS error, IN/KF_N: North channel RMS error, IN/KF_T: Total positional error, Unit: meter

Table 5: Performance summary (test trajectory)

outage periods) were implemented. Then, the results predicted by both navigators were compared with the reference trajectory for further analysis. The goal of those scenarios is to evaluate the performance of conceptual intelligent navigator in more realistic environment.

The stored navigation knowledge was acquired using the IMU and GPS measurements obtained through first two field tests. In addition, the window based weights updating strategy was applied to update the navigation knowledge during the availability of the GPS signal during the test trajectory. The window size was set to 60 seconds; however, the conceptual intelligent navigator was switched to prediction mode using the latest updated navigation knowledge acquired using pervious GPS window information whenever a GPS outage took place.

Table 5, Figure (7) and Figure (8) compared the performance of conceptual intelligent navigator (IN) and traditional navigator (KF). As indicated Table 5, the conceptual intelligent navigator was superior to traditional navigator in both scenarios. The averaged improvement of conceptual intelligent navigator reached 47% and 78%, respectively.

As indicated in both Figures (7) and (8), the positioning accuracy of traditional navigator decreases with longer GPS outage period. In other words, Table 5 illustrates that the improvement introduced by the conceptual intelligent navigator increases with longer GPS outages. The oscillations observed from Figures (7) and (8) were mainly affected by the motion dynamics of the vehicle. General speaking, both figure demonstrate that the time impact on the positioning accuracy of traditional navigator was more significant than the impact of motion dynamic on the positioning accuracy of conceptual intelligent navigator. In addition, such impact can be further reduced by expanding the architecture of PUA to receive additional navigation knowledge from DGPS.

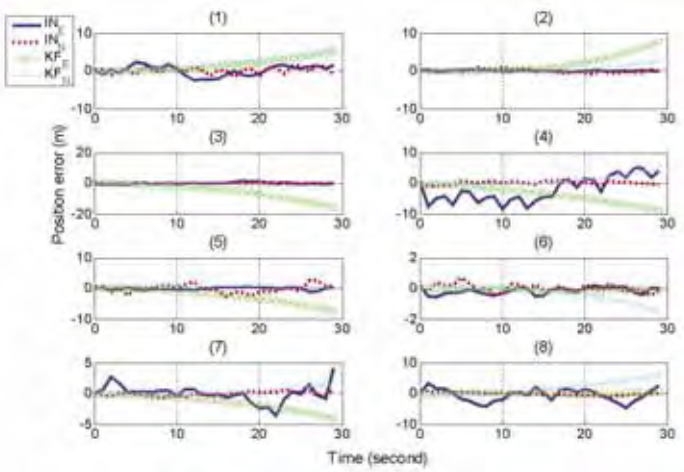

Figure 7: Positional error (30s scenario)

The most important factor that affects the performance of the conceptual intelligent navigator is the accumulation and evolution of navigation knowledge. Theoretically, if enough navigation knowledge can be acquired in one or fewer field tests, the conceptual intelligence might be able to operate in full prediction mode for every new navigation mission. However, the knowledge accumulation should be conducted whenever new navigation knowledge is acquired as the true motion dynamics of the vehicle operating in real life is far more complicated.

With the presence of the conceptual intelligent navigator, the traditional navigator that uses a Kalman filter should be regarded as an optimal estimator, instead of a navigator, as it doesn't have any ability to store and generalize the navigation knowledge that it has learned. In contrast, the conceptual intelligent navigator has the ability to generate, store and generalize the navigation knowledge it has learned.

Comparing to traditional navigator, the conceptual intelligent navigator demands more storage space to store the navigation knowledge. As the accumulation of the navigation knowledge makes the conceptual intelligent navigator different from the traditional navigator, it is the price to pay.

Given the fact that the incorporation

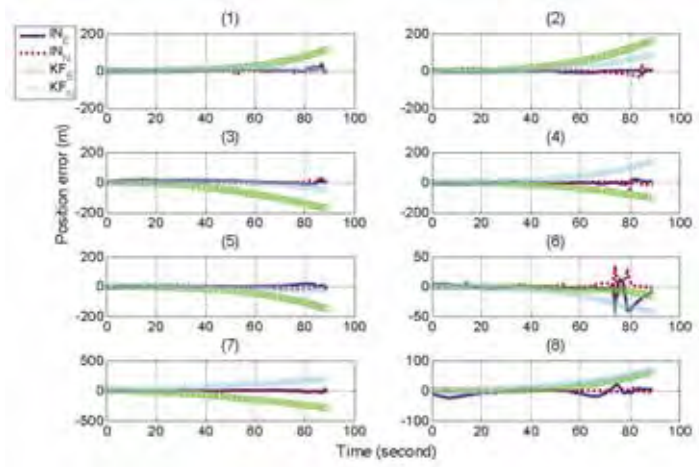

Figure 8: Positional error (90s scenario)

of artificial intelligence to the navigation algorithm is new to the navigation community, it needs more extensive research to accelerate wider inclusion of such an idea to commercial products. In fact, using artificial intelligence for mobile robot navigation has been studied extensively in robotic engineering related research works since the field of artificial intelligence started. Therefore, developing a new artificial intelligent INS/GPS integration architecture that can overcome some of the limitations of the traditional navigator in a land vehicle environment is a huge challenge. However, the results presented in this article strongly indicate the potential of including the artificial intelligence as the core navigation algorithm for the next generation land vehicular navigation system.

Conclusion

This article exploited the incorporation of artificial neural networks to develop an alternative INS/DGPS integration scheme, the conceptual intelligent navigator, for low cost MEMS IMU/ DGPS integrated land vehicular navigation system. The preliminarily results presented in this article reached the goal which was set to reduce the positional errors, generated by the limiting factors of traditional navigator, during GPS signal outages.

The conceptual intelligent navigator was able to improve the positioning accuracy during GPS signal outages applied in both scenarios. The overall improvement reached 47% and 78, respectively. The results presented in this article illustrated that the positioning accuracy of traditional navigator decreased with longer GPS signal outage period. In contrast, the positioning accuracy of the conceptual intelligent became more significant with longer GPS signal outage periods.

Given the fact that the incorporation of artificial intelligence to the navigation algorithm is new to the navigation community, it needs more extensive research to accelerate wider inclusion of such an idea to commercial products. However, the results presented in this article strongly indicate the potential of including the artificial intelligence as the core navigation algorithm for the next generation land vehicular navigation system.

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Make maps quickly

Innovative use of controlled photogrammetric models allows for faster map making

PROF P MISRA

Seven out of ten customers of surveys and mapping who talk to the suppliers (consulting firms of surveying agencies) demand their maps to be delivered `yesterday'(!) or indeed as early as possible. These customers are `decision-makers' who have taken some months (if not years) to come to the demand level! Same is the situation in respect of the tenders in mapping discipline. All the risks and uncertainties are put on the door of the suppliers / contractors. One should realize that although the surveying and mapping process never costs more than 1 or 2 percent of total budget, the same is not true when it comes to the time taken for the mapping project. The fact is that many projects are delayed just because the survey data of right quality and proper map was not made available to the engineer / planner.

The above scenario, although quite common and acceptable through usage, should make people think about the cardinal question – Can we cut short or minimize the time taken for the survey process and deliver the map tomorrow if not yesterday? Survey profession will definitely earn brownie – points if the process becomes quicker.

This paper tries to answer this question. Some innovative juxtaposition of the photogrammetric production process has been suggested towards this goal.

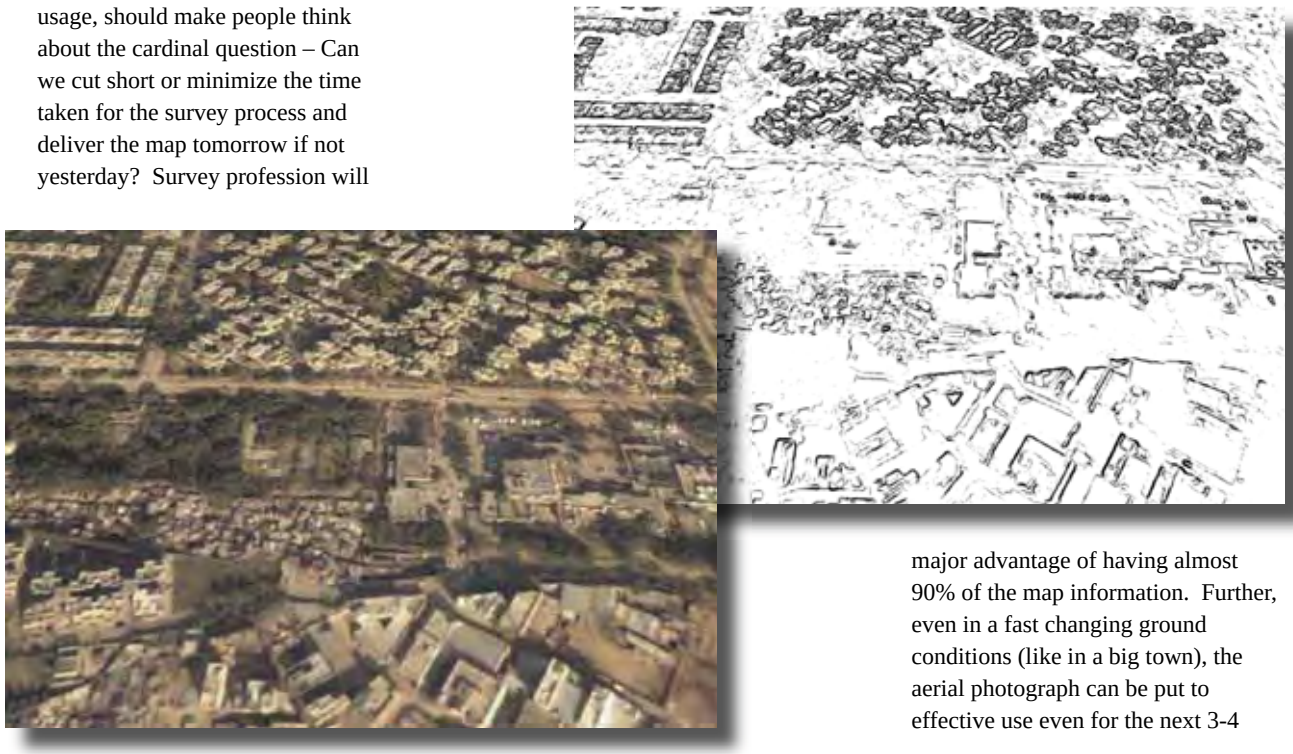
In order to reduce the time of production, we have to examine the photogrammetric production processes.

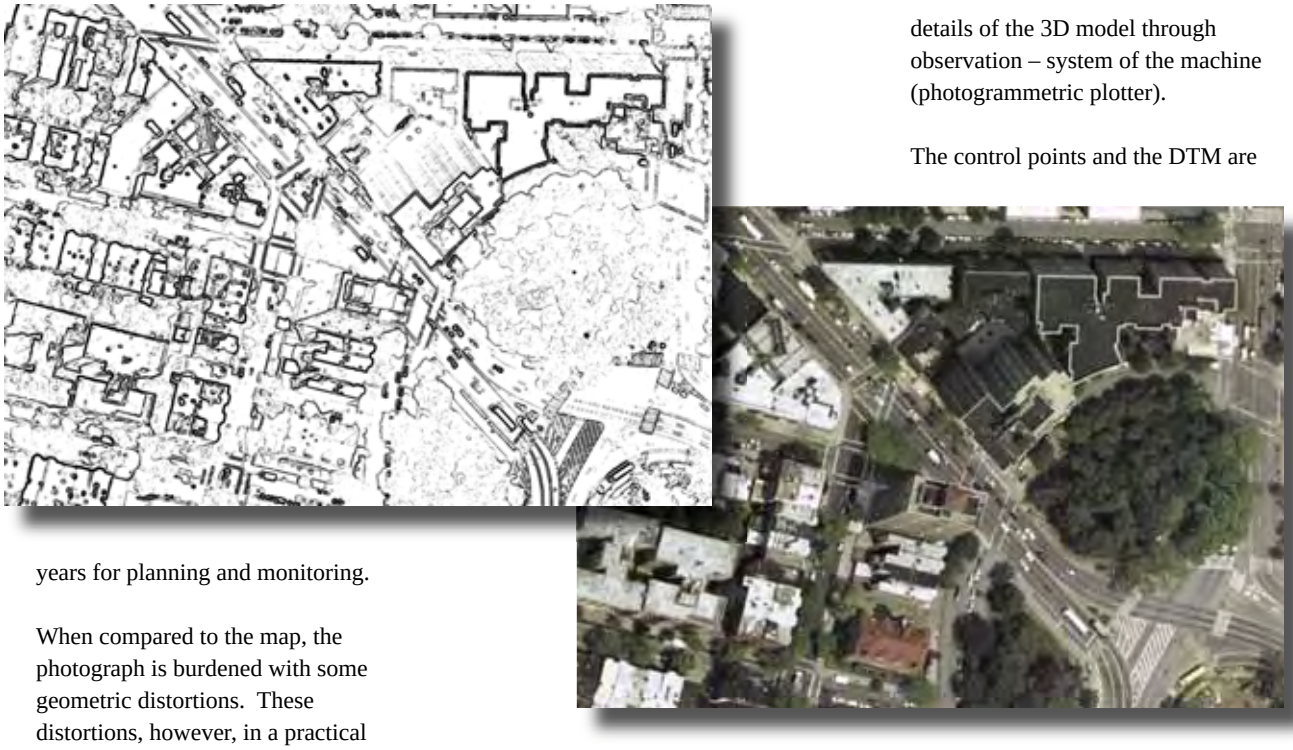
The sub-process or various steps in the photogrammetric processes are further analysed towards arriving at the solution.

Aerial Photography – Treat this as 90% Map

The aerial photography in India is carried out by the National Remote Sensing Agency, (NRSA) located at Hyderabad. The specialized aircraft and other equipment are also stationed at Hyderabad. The cost of aerial photography, therefore, very much depends on the distance of the desired survey site from Hyderabad. The security clearance of the aerial operation is taken by the NRSA but it takes a few months. Besides, the flying season commences in September and finishes in March / April. Looking at this scenario, the customers are well advised to enter into dialogue with NRSA right at the conception stage of the Project and not wait for the sanction of the Project. There is no cost of discussions leading to the stage of obtaining security clearance.

To give an idea, the cost of the aerial photography for an area in Delhi may range from Rs 40 to Rs 50 per hectare on 1:10,000 scale. The cost when compared to the overall cost of photogrammetric mapping i.e. Rs 400 to Rs 500/ha, is quite low. Consider this with respect to the major advantage of having almost 90% of the map information. Further, even in a fast changing ground conditions (like in a big town), the aerial photograph can be put to effective use even for the next 3-4





years for planning and monitoring.

When compared to the map, the photograph is burdened with some geometric distortions. These distortions, however, in a practical sense are quite insignificant if the terrain is flat. The nominal scale of the aerial photograph can also be determined with the help of flying height of the aircraft at the time of taking photography.

Ground Control – Vital Input to Photogrammetry

When Photogrammetry is employed as the main production technology, there is considerable (almost 60 to 70%) reduction of ground control work in the field as compared to purely ground based traditional techniques. However, Photogrammetry stipulates a minimum number of ground points at proper location with respect to the incidence of the aerial photography (model) on the ground. These ground control points create the most important input to the process of Photogrammetry.

It is presumed that the ground control points will be provided with the help of Global Positioning System (GPS in differential mode). These points are further connected to the Survey of India Stations and Bench Marks.

Aerial Triangulation (AT) and Digital Terrain Model (DTM)

This is an essential photogrammetric operation in which initial ground control (as mentioned in 2.2) is augmented by a set of procedures on a photogrammetric machine. The result is that all the overlapping aerial photographs (stereo-models) will have control points at optimum places. These control points obtained after aerial triangulation are marked on photographs and are later required for producing mapping details (x, y and z) in case line map is required. A fully digitised vector map can also be produced at this stage.

Digital Terrain Model is produced using a mesh / grid of elevation points. Closer the grid, the more accurate is the DTM. The DTM provides a `well approximated' model of the terrain. The digitised data in DTM form can be further utilized to generate contours and / or Orthophoto.

Photogrammetry Based Mapping (Plotting)

The photogrammetric model is set on the machine very accurately with the help of the augmented points. The digitisation of the mapping details (topography) and the elevations / contouring is done automatically while the operator is going over the details of the 3D model through observation – system of the machine (photogrammetric plotter).

The control points and the DTM are also used for incorporation in the Geographic Information System (GIS) and for generating an Orthophoto.

Orthophoto is a digitised transformation of original photograph from which all distortions have been removed and proves more productive than traditional line-maps. The Orthophoto combines the richness of aerial photo and the accurate geometry of a map. Incidentally, the Orthophoto mapping process is also more cost and time effective when compared to line mapping on a photogrammetric plotter.

Photogrammetric Output

The photogrammetric output, as mentioned earlier, can be in the form of a line-map with contours or as an Orthophoto of the area. These are the standard map-forms especially for large-scale work e.g. utility maps of towns, highway corridor maps, water pipe network surveys etc.

Field Verification of Photogrammetric Output

There are many physical features, which are not photographed or are omitted e.g. houses under trees, underground pipe lines etc. These

features are picked up by ground-visit. The output is, in general, checked for any omissions or wrong interpretation also. In case the photography is not very old (more than 3-4 years) and the changes on the ground are not many, say 10-15%, the changes can be surveyed on the ground at the time of verification.

Photogrammetric Production Process and Recommendations

Aerial Photography

Aerial photography, as discussed, should be procured as early as possible. It is a low investment activity yet forms an important step. All (100%) ground-based information is available except the `geometry' of a map in an aerial photograph. Many requirements e.g. planning process, environmental monitoring, ground water studies etc can be met from an aerial picture.

Controlled Models

The next stages of field control, Aerial Triangulation and preparation of DTM will add `geometric value' to the aerial photography.

This is the desired stage at which the value added data and the aerial photography can be stored so to say. In other words, it means that the aerial photograph along with its value added data is ready for any mapping requirement.

This will be the Photogrammetric Digitised Data Base (PDDB), which can be `retrieved' to produce a map within a very short time of a week or two. We can forget about the delays of some months if not years if the Data Base is already available in an organization. PDDB will create an effect of fast-forward in a mapping organization like Survey of India, National Remote Sensing Agency, State Cadastral Organizations and similar organizations. The mapping organization will improve the delivery by a factor of 12 to 15 times. The common time of production is reduced from 24 weeks to 2 weeks.

The above concept of Photogrammetric Data Base also facilitates the user-organization to spread its expenditure over a longer period of say 2 to 3 years. Thus, the concentrated load of costly mapping is also easily distributed in budgetary allocation of organizations.

The concept is so useful that any user organization requiring detailed and accurate maps can get these very quickly.

Achievable Accuracy at Different Scales of Aerial Photography

The scale of aerial photography is designed before it is actually flown. The possible accuracy from the various scales of aerial photography is now discussed.

It is assumed that smallest topographic detail on the aerial negative (or diapositives) which is discernable on the photograph ranges from 20 micron to 40 micron, micron being 1/1000th part of one millimetre, Example – Assuming 40 micron on Negative. It the scale of photograph is 1:20,000, the smallest dimension converted in terms of ground will be:

$$\frac{40}{1000} \times 20000 \text{ (mm)}$$

$$= \frac{40}{1000} \times 20000 \text{ (mm)} \times \frac{1}{10} \text{ (cms)}$$

$$= 80 \text{ cms}$$

On the analogy of the example, a table can be prepared.

Table – 1

Scale of Aerial Photography	Smallest Dimension on Ground
1:10,000	40 cms
1:20,000	80 cms
1:40,000	1.60 metres

The scale of map is generally 4 to 5 times larger than the scale of aerial photography. For example, 1:4000 cadastral map can be prepared from the aerial photography on the scales of 1:15,000 or 1:20,000 scales. Utility mapping for towns, which is required on 1:2000 scale, can be prepared from 1:10,000 or nearby scale.

Conclusion

The motivation for this paper started from seeking a solution of a real problem of the map users i.e. the inordinate delay in getting map-data. The concept of generating the Photogrammetric – Date – Base does solve this problem in two ways. Firstly, by procuring the aerial photography at the earliest and secondly by storing the value added models (partially completing the photogrammetric process). Once the user organizations understand the advantages of the concept, the implementation of the model is quite easy.

Another acceptable advantage of the concept is that it facilitates organizations to spread the expenditure over a longer period of time.

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Misdirecting GPS maps appear in Chinese markets

A number of people in China are having trouble with GPS navigation systems in their cars, because they are installed with counterfeit electronic maps, but authorities are doing nothing about the problem as there are no laws regulating the industry. Over the past six months, the Chinese Academy of Surveying and Mapping has granted eight companies across the country a certificate allowing them to produce electronic navigation maps.

Industry sources, however, say the number of fake maps on the market far exceed the number of genuine ones.. The electronic maps allow the system to tell drivers the best route to take to any destination. Legal maps cost more than 1,000 yuan (US$123) a piece, while counterfeits can sell for as little as 15 yuan. *www.shanghaidaily.com*

UAE invests to check vehicle speed

The UAE is investing $125m in a system that will make it possible to determine the speed of any of the Gulf state's 2m vehicles, no matter where they are. New devices, now being developed by the UAE's Centre of Excellence for Applied Research and Training (CERT) in conjunction with IBM, should be ready for installation in cars within four years. Once fitted, these devices will use GPS satellites to determine the car's location to within a few metres. By combining several position and time measurements, it is a simple matter to determine the car's speed. *epaperdaily.timesofindia.com*

GPS to track delivery of readymix to construction site

Delivering readymix concrete at this time of year is a battle against the clock as well as the thermometer. As the temperature starts to rise, any delay in the delivery of readymix to site can result in the cement solidifying and spoiling before the contractor gets to start the pour. And with traffic congestion becoming an increasing problem in many construction industry hot spots throughout the Gulf, delivery delays are becoming more common. But one Bahrain-based concrete supplier hopes that receiving angry calls from contractors demanding to know what has happened to their delivery will be a thing of the past, thanks to a new tracking system, which allows them to keep tabs on their trucks. The Eastern Asphalt & Mixed Concrete Company (Eamco) is set to finish installing MobiApps, a fleet management system, on its 45 cement mixers and 15 pump trucks by the end of the month. The system will allow Eamco to monitor its drivers' activities in near real time, which will then enable management to keep a better watch on staff and also to inform customers about delays as they happen. *www.itp.net*

Earth`s crust pulsates in the Amazon basin

Earth`s crust pulsates up and down in the center of the Amazon basin, new research suggests, according to researchers in Brazil and United States. A GPS located next to the Amazon and Rio Negro rivers in Brazil, recorded the station`s altitude from 1995 to 2002. During that period the station oscillated up and down within a range of about 75 millimeters, or 3 inches, which was 3 to 9 times larger than observed at GPS stations around the world. Michael Bevis of Ohio State University in Columbus, working with a team of colleagues, compared vertical crustal displacement with the fluctuation of the water level in the river and found an almost perfect anti-correlation. As the river rises, the ground sinks. Conversely, as the river level falls in the dry season, the solid earth rebounds. *http://science.monstersandcritics.com*

Truck firms in Philippines urged to use GPS

The Calabarzon police office in Philippines has asked the association of trucking companies in the region to immediately install GPS gadgets in their trucks to thwart hijacking and highway robberies. Although the number of reported hijackings had declined in the past months, the threat was still high. Once installed the GPS could show the exact location of the trucks at any given time. In case a truck is taken by criminal elements or during an emergency, the police and its owner can easily detect where the truck is headed. Then police units can be dispatched to go after the truck at once. He said despite the availability of such technology in the country, the number of trucking companies using GPS in their units is still negligible. The most common reason cited by companies, he said, was that GPS units are expensive. *http://news.inq7.net*

Massive sunspot causing problem to GPS equipments

A sunspot five times the size of Earth could wreak havoc with satellites and radio communication systems, scientists warn, as it moves across the face of the sun and Earth and moves directly into its firing line. Seven huge X-class flares have already erupted from the spot, including one of magnitude X17 that made it into the record books as the fourth largest ever seen. The US National Oceanic and Atmospheric Administration (NOAA) said that the flares have already caused problems with some electric power systems, radio communications and global positioning equipment. *www.theregister.co.uk*

GPS modernization begins with Delta rocket launch

A Boeing Delta 2 booster launched the first modernized Global Positioning System satellite to build a bridge from the navigation network of today to the advancements of tomorrow.

The two-ton GPS 2R-M1 spacecraft rode its three-stage launcher into a

temporary, looping orbit stretching from 150 to nearly 11,000 miles where the Delta successfully released its payload nearly 25 minutes after liftoff. Ground controllers will spend the next several days guiding the $75 million satellite to its final destination by firing an onboard kick motor to raise the orbit's low point. The power-generating solar panels will be deployed and antennas unfurled during the critical early days, too. *justin@spaceflightnow.com*

GPS device to track down racehorses

Racing has got a new piece of hi-tech kit, which monitors racehorse performance and simultaneously relays the information anywhere in the world. The new system has been developed by Cambridge Design Partnership together with British Endurance Riding Association Team member Dominique Freeman in U.K. It combines a GPS receiver with biological and environmental sensors in a single lightweight package carried by the horse. The device can simultaneously monitor the horse's performance, physiology and environmental conditions. This can be displayed in real-time to the rider and transmitted live around the world. *www.cambridge-news.co.uk*

GPS to monitor sex behavior of giant pandas

Chinese and American scientists are using the GPS to monitor the sex behavior of giant pandas in deep mountains. The Chinese Academy of Sciences (CAS) Institute of Zoology and the US Zoological Society of San Diego are joining hands in a three-year giant panda observation program in the Foping Natural Reserve of northwest China's Shaanxi Province, which costs 660,000US dollars. Hypogenesis and incretionary disorder make female giant pandas hard to get pregnant. Scientific statistics indicate that 78 percent of female giant pandas are unable to get pregnant while 90percent of males are sterile. Tracking them with advanced technologies and observing their sex activities might help us find ways to avoid their extinction. GPS and other computerized geographical systems could help scientists track movement of the surveyed in different seasons and the animals' behavioral change in different environments. *http://news.xinhuanet.com*

History lessons now equipped with GPS

A new project is linking history with new technology. Sixth formers are to use GPS to show tourists historic sites in a Denbighsire town in U.K. The history students at Ysgol Brynhyfryd will be equipped with palm-held computers showing Ruthin's historic buildings via GPS. Data will be accessible via the computers close to sites when students act as tour guides later this month. The A-level pupils have already digitised documents found among the archives in the town. *http://news.bbc.co.uk*

Products

Leica bags big GPS Surveying Systems order

Leica Geosystems has supplied 84 GX1230 dual-frequency GPS survey receivers for RTK data and GeoOffice post-processing software for 11 locations. Technical support and service will be provided under a five-year service agreement. The GX1230 receivers are designed with Leica Geosystems' new SmartTrack GPS measurement engine, and incorporate fast self-checking RTK algorithms and a comprehensive self-explanatory graphical user interface. The rugged GPS instruments, with magnesium alloy construction, are built to the toughest MIL specifications to withstand extreme field conditions. The SmartTrack technology ensures reliable centimeter-accuracy solutions at distances of 30 km or more. *www.leica-geosystems.com*

Trimble introduces TSC2 Controller

Trimble has introduced the TSC2 Controller, an advanced handheld field computer that provides wireless operations in both field and office. Designed for Integrated Surveying™ solutions using both GPS and optical total stations, the Trimble TSC2 Controller offers surveying, mapping and construction professionals increased efficiency, flexibility and versatility. Equipped with Microsoft Windows Mobile™ software for the Pocket PC operating system, the TSC2 controller will run the user's choice of Trimble field software. Users can also add specialized Pocket PC applications to the Microsoft Pocket Messaging (Outlook), Internet Explorer, Word and Excel that come standard to make the TSC2 a powerhouse of field and office functions in one rugged business device. *www.trimble.com*

Spectra Precision LL400 Laser Level

Trimble recently introduced the new Spectra Precision LL400 Laser Level, a ruggedized, fully automatic self-levelling laser level for concrete and site preparation applications. The LL400 Laser Level sets a new standard in reliability, handling a wide variety of general and concrete construction applications. Even in tough job site conditions, the LL400 consistently delivers reliable, accurate performance to increase overall productivity and cost-savings. *www.trimble.com*

SatNav launches new vehicle navigation system

Hyderabad-based SatNav Technologies in India is all set to launch a new version of its in-vehicle navigation solution. It will be launching SatGuide version 2.0, a pocket PC version of navigation system in India next month. They have developed this product in collaboration with MiTAC, Taiwan and Destinator, Canada. They have signed a partnership agreement with Nippon India for marketing and sales of the products. *www.newindpress.com*

Bentley offers free CAD software in nine languages

Bentley Systems recently announced that BE Careers Network has expanded its offer of free MicroStation PowerDraft CAD software to all students and instructors to include versions in the following nine languages: simplified Chinese, traditional Chinese, Czech, English, French, German, Italian, Korean, and Spanish. MicroStation PowerDraft is a professional-level application used for production 2D/3D drafting and detailing in architecture, engineering, and construction (AEC). It features an easy-to-use graphical user interface, intuitive viewing techniques, and an innovative set of industry-recognized tools for production work. *www.bentley.com*

NavCom Technology Launches New 12 Channel GPS

NavCom Technology, Inc announced today the introduction of the new NCT-2100D, a 12 channel, dual frequency GPS engine. The NCT-2100D is a form fit, pin compatible replacement for NavCom's existing 10 channel GPS engine providing a seamless upgrade path for both OEM customers and NavCom's fully integrated GPS receivers. *www.NavComTech.com*.

Enhanced viewing capabilities of the SUMMIT EVOLUTION™

DAT/EM Systems International has enhanced the viewing capabilities of the SUMMIT EVOLUTION™ Digital Stereoplotter by integrating Planar's SD1710 3D desktop monitor as an optional component of the system. The Planar1710 system has been installed at several DAT/EM client sites with extremely positive feedback. The image viewing quality is clear and crisp, rivaling that of older analytical mapping systems. *www.datem.com*

MapInfo Releases Exponare® v2.4

MapInfo Corporation announced the availability of Exponare ® v2.4. MapInfo Exponare®, a suite of centrally deployed map-enabled applications, provides an intuitive means of channelling vast amounts of disparate data, residing in various systems and formats, through a single portal to give decision makers the ability to turn data into information and share that with internal and external customers, without the need for software development skills. *www.mapinfo.com*

Latest version of Cadcorp SIS announced

Digital mapping and GIS software developer Cadcorp of U.K. has announced the latest version of the Cadcorp SIS – Spatial Information

System software suite, Cadcorp SIS Version 6.2. This latest version of Cadcorp SIS introduces many new and enhanced features designed to enable organisations to realise efficiency gains from increased productivity, improved information sharing and customer self-service. The ability to directly read almost 150 native GIS, CAD, graphic and database formats without translation enables organisations to maximise their investment in existing data by integrating disparate data types, including data from legacy systems. *www.cadcorp.com*

NIEHS launches website for assessing environmental hazards

A new website with a Global Information System will provide valuable information for assessing environmental hazards caused by Hurricane Katrina. The National Institute of Environmental Health Sciences (NIEHS) in U.S. one of the National Institutes of Health, created the website to provide the most updated data to public health and safety workers on contaminants in flood waters, infrastructure and industry maps, as well as demographic information for local populations. The NIEHS Hurricane Katrina Information Website accessible at http://www-apps.niehs.nih.gov/katrina/ provides information on assessing and evaluating hundreds of potentially hazardous environmental pollutants that may pose a risk to human health. *www.nih.gov*

Hurricane hunters use u-blox GPS technology

u-blox America recently announced that the National Center for Atmospheric Research (NCAR) uses u-blox GPS technology to determine the strength, direction and speed of hurricanes. u-blox is an international company headquartered in Switzerland which develops leading positioning products based on the GPS for the automotive and mobile communications markets., Most recently, close to 40 sondes have been employed to measure the characteristics of hurricane "Katrina" so as to study and predict its behavior. NCAR, which works closely with the U.S. government's National Oceanographic and Atmospheric Administration (NOAA), has designed a highly sophisticated GPS dropsonde that is used by the 53rd Air Force Reserve Weather Squadron (AFRES). *www.prnewswire.com*

SiRFstarIII powers Garmin's personal training system

SiRF Technology Holdings has recently announced its flagship SiRFstarIII architecture is being used by Garmin International Inc., a unit of Garmin Ltd. to provide GPS positioning capabilities for the Edge, a new line of integrated personal training systems designed for recreational and advanced cyclists. The Edge is the first Garmin device to incorporate SiRF's flagship SiRFstarIII architecture. *www.sirf.com*

MapWorld Technologies provides location tracking

MapWorld Technologies, a GIS and GPS based solutions provider in India is developing an SMS-based application integrated with a GPS for location tracking of vehicles and employees. The proposed application is expected to be available in the market by end November 2005. According to MapWorld, the applications main map would be deployed on a central system and inputs would be loaded on to the employees' mobile handset. Since the input from the mobile handset to the computer is SMS-based it will cost relatively cheaper. *www.ciol.com*

Business

Fugro increases its presence in oil and gas sectors

Dutch company Fugro has signed letters of intent to acquire Elcome Surveys Pvt. Ltd in India. The earlier announced joint venture with Oceansatpeg in Brazil will be operational as from 1 October 2005. Elcome Surveys Pvt. Ltd is located in Mumbai, India. The company is a supplier of survey, geotechnical and oceanographic services offshore India and in the Arabian Gulf. The acquisition will strengthen Fugro's resources base in this growing region. *www.fugro.com*

ORBIMAGE to purchase assets of Space Imaging

ORBIMAGE Holdings recently announced that it has entered into a definitive agreement to acquire the assets of Space Imaging LLC. Under the asset purchase agreement, ORBIMAGE will acquire substantially all of the assets of Space Imaging. The total consideration for the transaction is approximately $58.5 million less amounts, which will be paid by Space Imaging on its existing debt prior to closing as well as certain other adjustments. The transaction is subject to government regulatory approvals and other customary closing conditions. ORBIMAGE is optimistic that such conditions will be satisfied in time for the closing to occur on or prior to December 31, 2005. *www.orbimage.com*

Infotech Enterprises wins GIS contract from KPN

Infotech Enterprises Ltd. In India announced that it has been awarded a major GIS contract by Dutch company Royal KPN NV. Valued at several million euros and with a tight schedule of 18 months, it represents one of the largest, single-vendor GIS contracts awarded by a global telecom company to an offshore IT services firm in recent years. Infotech Enterprises will provide a range of data management services for KPN's existing Access Network. An offshore production team of around 300 data specialists based in India will perform conversion services remotely to digitize KPN's existing telecom network. The company will utilise a secure, online delivery model to ensure that the project is delivered to KPN's quality, schedule and budget expectations. *http://indiainfoline.com*

Large scale topographical mapping for Republic of Maldives

NRSA has carried out mapping of entire Maldives at 1:25000 and sixteen selected islands at 1:1000 scale for the first time in the history of Maldives

V Raghu Venkataraman, P Srinivas, K Sreenivasa Rao, CVKVP Jaganaatha Rao, G Srinivas, J Narendran

The Republic of Maldives is an archipelago (group of Islands) in the Indian ocean with 1190 islands few of which are inhabited and many are uninhabited Islands. The islands are grouped in the form of atolls. An atoll is a coral island consisting of a circular belt of corals enclosing a central lagoon and Maldives consists of 25 atolls. The land portion is around 300 Sq. Km. out of 100,000 Sq. Km. while the rest of the area is covered by water.

The basic objective of the project is to prepare Large scale topographic maps of different islands of Maldives. National Remote Sensing Agency (NRSA) was entrusted this task as part of a Memorandum of Understanding between Ministry of External Affairs, Government of India and the Ministry of Planning and National Development, Republic of Maldives. Many organizations and firms tried in the past to carry out this task and they were unsuccessful.

NRSA carried out aerial photography at 1:40000 scale to map the entire Republic of Maldives at 1:25000, sixteen selected islands are flown at 1:6000 to map in 1:1000 scale and a reference datum for Maldives in WGS-84 is established for the first time.

Project Objectives

The major objectives of the large scale topographic mapping project for Maldives are

1. Establishment of a reference network in WGS-84 datum using GPS.
2. Preparation of digital maps of entire Maldives on 1:25000 Scale.
3. To prepare large scale digital maps on 1:1000 scale for sixteen selected islands.

The following methodology was adopted for this project and each and every stage of the project is explained in detail.

Reference network in WGS-84 Datum

Thirteen reference stations spread over the entire country were identified and monumented to establish a reference network for Maldives. The map of Maldives was divided into seven blocks for planning and execution of this task as shown in fig.1. The georeferenced IRS-1D LISS-III satellite images were mosaiced seamlessly for contiguity and proper planning of photo target points and GPS reference stations. The reference stations were located in such a way that at least one reference station is there in one-degree grid. Each reference station was occupied with geodetic grade dual frequency GPS receivers for a minimum of three

Pairs for duration of 12 hours from 6AM to 6PM every day. The Male IGS station was also occupied as part of this GPS survey campaign. The GPS data was processed in a scientific post processing software Bernese, which is capable of processing long GPS baselines and the coordinates of the reference stations were computed using the data from the nearest IGS stations. Thus a reference network of thirteen reference stations for Maldives was established.

Aerial Photography

The Republic of Maldives extends from 1°S to 7° N Latitude and 72° to 74° E Longitude approximately. Since the majority of the area is covered by water, effective flight planning was a important and critical component for this project. Information from satellite images, existing atlas maps, old maps etc., were used to prepare optimized flight plans so as to make flying economical and minimize wastages. A mosaic image of the Republic of Maldives was prepared using IRS-1D LISS-III satellite data comprising 23 scenes and the mosaic was used in the flight planning for the entire Maldives, this has ensured that no island is missed for aerial photography.

The flight plans were generated using World Wide Mission Planning (WWMP) software and the preplanned exposure coordinates were incorporated in the Computer Controlled Navigation System (CCNS). Aerial photography (Black & white) was carried out using Beechcraft Super King Air B-200 mounted with Zeiss RMK 15/23 metric camera and integrated with INS and Kinematic GPS. The aircraft is guided by Computer Controlled Navigation System (CCNS) software for carrying out aerial photography very accurately. The camera is tightly coupled with CCNS which in turn connected to airborne GPS. The scale of mapping using 1: 40,000-scale aerial photograph is 1: 25,000 scale for entire Maldives and sixteen selected islands were mapped at 1:1000 scale using aerial photographs of 1:6000. The GPS reference stations thirteen in number were also used as reference stations for the airborne GPS assisted aerial photography of Maldives. The exposure station coordinates were computed by differentially processing the airborne GPS data with reference to reference station GPS data using GPSurvey software.

Ground Control Points

Forty two Pre-target Ground control points spread over the entire country were established for carrying out mapping at 1:25000 scale. The pre-targets are 3m X 3m in dimension with plus mark in Black and remaining area in white. Each pre-target was occupied with a geodetic grade GPS receiver for a duration of 3 hours and the data was processed differentially with reference to the reference station identified as part of datum establishment using SKIPRO software. The establishment of GPS reference stations, airborne GPS assisted aerial photography and occupation of pre-targets were taken up during the same period so that reoccupation of the reference stations could be avoided.

The GCPs for mapping sixteen selected islands, separate GPS survey was carried out by selecting suitable control points on ground and corresponding nearby reference stations were occupied simultaneously to differentially process data and to determine the control point coordinates.

Aero Triangulation and Block Adjustment

The B/W film was developed in the photo laboratory at NRSA and negative rolls were scanned using high precision photogrammetric scanner i.e., Zeiss SCAI and the scanned images were used for further processing on digital photogrammetric workstations.

The Automatic Point Matching (APM) module was used to generate pass & tie points. The aero triangulation was carried out using SOCET SET Photogrammetric software and bundle block adjustment was done with ORIMA block adjustment software. The aero triangulation and block adjustment step was very crucial and was done in a systematic manner since APM in this type of terrain is very difficult because most of the area is covered with water and the land portion with features is minimal. The availability of Kinematic GPS coordinates of exposure station, coordinates of pre-targets and with the APM techniques the seven blocks as planned could be photogrammetrically adjusted satisfactorily.

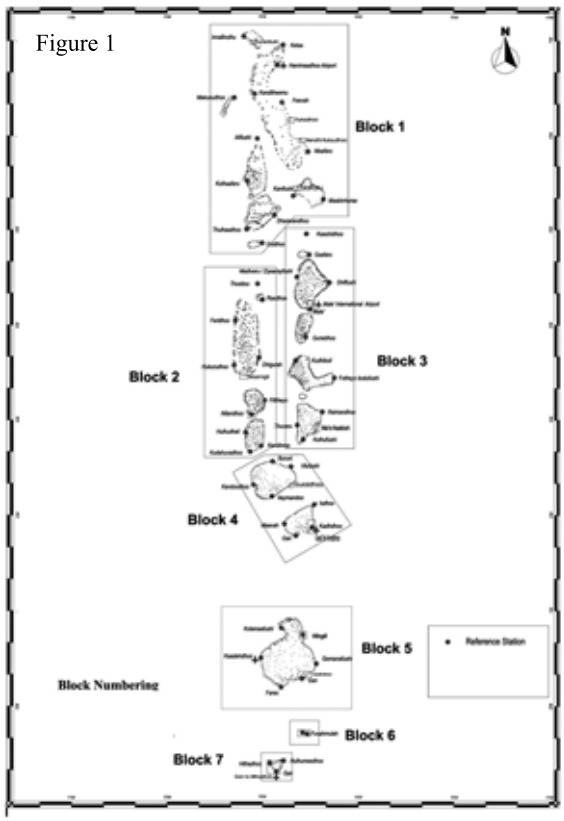
Mapping of the Islands

The vector data model for mapping the Islands of Maldives were developed, it includes layerization, line types, point symbols, hatch patterns, text fonts, mockup etc. The digital vector capture was done using Microstation/ AutoCAD mapping software which was interfaced to digital photogrammetry workstations. The digital data is in AUTOCADD format and were imported to ARCGIS environment for further analysis.

Field Verification, Field data collection & Hardcopy Plots

The field verification and field data collection at different islands of

Figure 1



Maldives were carried out using 4X enlargements of the aerial photographs and vector plots of each island. The field data, corrections and annotations have been incorporated in the final digital maps. The map composition or mockup for different scales has been prepared and hardcopy plots have been generated.

Quality Assurance/ Quality Control

The quality of the data has been checked at each and every step so that the data meets international standards. The vector data capture process was checked at three different stages one at the time of progress of the work and was it was carried out online, the second online total quality control at the end of vector capture process and at third stage the hard copy QC after the incorporation of the field data was done. The QA/QC was done to check the data in all aspects like interpretation, categorization, completeness, consistency in height information, layerization, symbology, topological aspects, GIS compatibility, annotation in terms of font and style, hatch patterns, mockup, orientation of textual information etc., of the data.

Mapping Schema

A mapping schema for the 1:1000 and 1:25000 scale maps prepared for the Republic of Maldives was developed at NRSA. The projection is in modified Universal Transverse Mercator (UTM) and the spheroid is WGS-84.

Conclusions

NRSA has carried out mapping of entire Maldives at 1:25000 and sixteen selected islands at 1:1000 scale for the first time in the history of Maldives. Many organizations and firms tried in the past to map the Republic of Maldives and they ended in failures.

The highlights of the project are

1. Establishment of a reference network in WGS-84 datum for Maldives.
2. Pre-targets & KGPS were effectively implemented.
3. Aerotraingulation for atolls, which is a group of scattered islands, was a very difficult task. We have gained valuable techniques and knowledge to carry out aerotriangulation and block adjustment for a difficult terrain.
4. Mapping numerous tiny islands and its environs was a unique mapping experience.

NRSA due to its vast experience in the area of mapping, took this task as a challenge, planned and executed each and every step carefully in a systematic manner and successfully completed the project in time.

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P Srinivas, Incharge, Quality Control Facility in AS & DP. He is working in NRSA for the past 12 years. He has been working in the field of Photogrammetry and GIS.

K Sreenivasa Rao, Incharge, Ground Control Facility in AS&DP. He is working in NRSA for the past 20 years. He has been working in the field of aerial photography, ground control surveys using conventional as well as modern technologies.

CVKVP Jaganatha Rao, senior Scientist/ Engineer in Airborne LidarTerrain Mapping (ALTM) Section. He has been working in NRSA for the past 10 years. He has been working in the field of Geophysics, aerial photography & flight planning, Digital Photogrammetry.

G Srinivas, Incharge, Aerial Surveys Facility in AS&DP. He is working in NRSA for the past 20 years. He has been working in the field ofaerial photography & flight planning, cost estimates, ground control surveys and photogrammetry.

J Narendran, Scientist, Quality Control Facility. He has been working in NRSA for the past 6 years. He has been working in the field of GIS, GPSsurveys and Mapping.

Aerial Services and Digital Mapping Area, National Remote Sensing Agency, Department of Space, Government of India

Building relationships

11th Technology summit strengthens Indo-Canadian relationship. 21-22 September 2005 New Delhi

The 11th Technology Summit and Technology Platform to promote International Technology Partnerships for the Indian Industry and R&D Organisations, was organized on September 21st to 22nd 2005, at Hotel Taj Palace, New Delhi. The Summit was jointly organised by CII and Department of Science and Technology, Government of India. This is in keeping with the ongoing efforts of CII and DST, which have been working together to extend the benefits of international linkages of DST to the industry. Such tie-ups include providing technology information and networking with overseas organisations. Canada was the partnering country at TechSummit2005.

Canada's participation was marked by the presence of some of Canada's best industry, research and academic institutions (115 delegates from Canada!) that were looking forward to partnerships with relevant Indian organisations. Mr Y P Kumar - Head International Division, Department of Science and Technology, Govt. of India remarked on the positive trend indicated in this year's Summit where more than 115 participants from Canada were present, unlike other years when the representation from the participating country was about a quarter of this number.

The focus, at the Canada Pavilion in the concurrent exposition – Technology Platform 2005, was on developing S&T linkages, for which a study was conducted earlier. Apart from the Governments of both countries, the summit had participation from among the best of industry, the academic world, transnational joint ventures in R&D institutions, contract research laboratories, technology financing organisations and transfer agencies.

Almost every section of Technology that affects the common man was covered at the Summit - Energy and Environment, Fuel Cells, Hydrogen Energy, Next Generation IT- Infotainment and Nanotechnology, with the focus on the following technology sectors:

- Biotechnology, Health Research and Medical Devices
- Nanoscience and Nanotechnology: The New Revolution
- Sustainable and Alternate Energy and Environmental Technologies
- The Next Generation of Information Technologies: Infotainment, Wireless, Rural Connectivity
- Earth Sciences and Disaster Mitigation Technologies
- Role of Public-Private Partnership in promoting Innovation

On the occasion V S Ramamurthy, Secretary, Department of science & Technology, Govt. of India while reinforcing the spirit of partnership in the globalised world of today, noted that ten years from now this Summit is going to be seen as a pathbreaking initiative.

Mr N Srinivasan, Director General, CII emphasized that India is looking forward technology as a Strategic tool for business, for sustaining competitiveness and also as a movement worldwide.

11th Technology Summit reflected a change in the mindset of the people – which is now determined to achieve progress through strengthening technology. Mr Kapil Sibal – Minister of State (Independent Charge) for Science & Technology Government of India reaffirmed his commitment to developing this path. He stated that today technology is not an esoteric thing, which was a confirmation of the fact that excellence of technology and the applicability of it was a positive reality. Mr Sibal thanked James Peterson, Minister of International Trade, Canada for getting such a remarkable team of delegates from Canada to accompany him to India. On behalf of CII he committed to be on the course to connect with the Indian industries and build a relationship between India and Canada. He emphasizes that we cannot afford to wait for 5-10 years to see the effects of this Summit. He was hopeful that entrepreneurs and technologists would work together to achieve substantially over the two days, of the on going Summit.

Dr Arthur J Carty, National Science Advisor to the Prime Minister, Canada asserted that Canada and

India have a common goal - Science and Technology and the only way to move forward is moving together.

There was a general agreement that Technology has to be for the common people. Canada's population of 38 million is a little over the national capital territory of India 's population of 1.1 billion. For Indian people have housing, water etc problems and technology had to reach both levels. Technology must reach the people on the streets that is the test of success for any collaboration, was the unanimous decision. Examples cited included that of bamboo, where technology has enabled extensive use even in building. Biotechnology is the other sector that can help in increasing the per capita growth of our country. Even in the Health sector specifically for the diseases of the poor - malaria, HIV and hepatitis technology has to make its contribution by developing vaccines and medicines and making them available at affordable costs to the poor.

There was an enunciation of the fact that three Ts are essential for excelling - Talent, Technology and Tolerance and both Canada and India have the three.More than 15 sessions took place at this summit, and 290 one-to-one meetings were co-coordinated between Indian & Canadian organisations. A session was also organised on Earth Science and Disaster Management where some interesting presentations were made both from Canada and India. The session focused on the importance and potential of geomatics sciences in disaster management.

James Peterson, Minister of International Trade, Canada

A total number of 300 people participated from industries and institutions in India. While 4 Expression of Interest were signed between Indian & Canadian Organisations, a Joint-Venture MOU was also signed between the Indian company Animation Bridge and Canadian company Kahani Inc. for Indian-themed Children's Television Series.

Kapil Sibal, Minister of State (Independant Charge) Science and Technology, India

The Government of Canada recently released a Canada-India Science and Technology (S&T) Study (www.dfait-maeci.gc.ca/asia/country/india-en.asp) which shows fields where the two countries can complement each other. It is such tested conviction that fuelled Canada setting aside in its 2005 budget $20 million over five years to support new international S&T partnerships with select countries, including India.

Canada's recently released International Policy Statement pays significant attention to India as well as S&T. Moreover, the CII Technology Summit continues from where the 2005 Canada-India Joint Statement issued by the two Prime Ministers and the Joint Declaration on S&T Cooperation signed during the recent Canada Trade Mission to India led by the Minister of International Trade, left off.

The timetable was also set for the Indo-Canadian Science and Biotechnology agreement between the ministers of the two countries, which will happen in the 3rd week of November this year. It has been planned to set up a Nanotechnology Centre in India and an initial round of discussions have taken place. Other areas of successful initiatives included the areas of Industrial R&D development and Joint Ventures.

Dr R A Mashelkar in his Valedictory Address insisted on the fact that the Technology & Innovation needs to be actively promoted under Public-Private partnership for effective results. He also cited success cases from Indian industry and institutions.

Dr Arthur J Carty, National Science Advisor to the Prime Minister, summed up the proceedings with a belief that the Summit will lead to concrete ideas and strengthen an Indo-Canadian relationship on Science and Technology. He hoped to continue renewing Canadian relationship with India to encourage the Indian community to come to Canada & vice-versa. He was also happy to declare that they were on their way to signing a couple of agreements in November already granted by the Canadian govt. for substantial collaborations.

Signal Propagation

In Satellite Geodesy signal propagation between satellites and ground stations is a very important aspect and need to be completely understood. The signals propagate through atmospheric regions of different nature and variable state, and thus experience different kinds of influences. There is scope for certain deviations in the direction, strength and speed of signal propagation. The impact of the atmosphere is to be assessed for obtaining accurate signal structure which has value and scope for application in satellite Geodesy. Consequently the atmospheric influences need to be quantified through measurements and subsequent model building. As such related fundamental characteristics of signal and wave propagation through the troposphere and ionosphere are reviewed below.

The relation between wave length λ, the propagation velocity v, and the frequency ' f ' is v = λf. Here λ has units of meters and f has units of 'Hertz' and v units of meters per second.

In electromagnetic theory the waves are considered as perturbations or deviations in time and space. If there is a disturbance or deviation 'y' occurring in the signal at a fixed point after a lapse of time known as period 'P', then the resulting signal structure is known as periodic wave. The frequency 'f' is equal to the inverse of the period P (f = 1/ P). A periodic wave, which can be modeled by a sinusoidal function in space and time, is a sinusoidal wave. Considering periodic waves,

$y = A \sin 2\pi[t/P + \Phi\circ]$

where y is the magnitude of disturbance at a given time t, $\Phi\circ$ is the phase of the wave at time t=0 and A is maximum amplitude of the wave. The phase of time 't' is given by $\Phi = [t/P + \Phi\circ]$ and $2\pi\Phi$ is called the phase angle Ψ and the angular frequency $\omega = 2\pi f$. From these definitions it follows that

$y = A \sin (\omega t + \Phi\circ)$.

At this stage we can define a fundamental relationship between the phase of periodic process and the corresponding time reading on the clock as $t = \Phi / f$. This relation forms the basis for deriving the observation equation of GPS phase measurements. A medium in which the propagation velocity of electromagnetic waves depends on the frequency is characterized as a dispersive medium. The dispersion effect is caused by the electromagnetic interactions between the electrically charged field of the medium and the characteristics of the intruding wave.

When the atomic frequency of the medium and frequency of the intruding wave are close together, a phenomenon called resonance occurs, which, in turn modifies the propagation velocity. This is defined as velocity dispersion, $\partial = dv / d\lambda$. In a situation where velocity dispersion ∂ is occurring, we can observe different propagation velocities for sinusoidal waves (phases) and groups of waves. At this stage it is much more relevant to understand and distinguish the phase velocity (v_p) and group velocity (v_g) as this is essential in applied geodesy to determine whether for a particular observable the group velocity or phase velocity has to be applied. In GPS the group velocity affects technology for instance, the propagation of code signals and the phase velocity affects the propagation of carrier phases. Here the Phase velocity v_p is defined as the propagation velocity of the phase of a particular wave with uniform wavelength. The group velocity v_g is defined as the propagation velocity of a wave group, generated by a superposition of different waves of different frequencies. Rayleigh has derived the classic relationship between group velocity and phase velocity as $v_g = v_p - \lambda [dv_p/d\lambda]$. The group velocity represents the speed at which the EM energy is propagated. The speed of propagation of Electro magnetic waves 'c' is estimated for application in satellite geodesy as C = 2.99792458 x 10 meters per second.

For frequencies in the optical region of the electromagnetic spectrum (ie for wave lengths within 0.35 to 3 microns approximately) the troposphere is the prime dispersive medium. However for microwaves the ionosphere is the dispersive medium and the troposphere does not have much influence. The frequency spectrum of electromagnetic waves contains nearly 20 orders of magnitudes. In satellite geodesy only rather small domains are used, viz., the visible region (about 400 to 700 nanometers which we affectionately call as 'Light') and the microwave region. The phase velocity in a dispersive medium can exceed 'c', the speed of propagation of EM energy in vacuum. The group velocity however cannot exceed in accordance with the classical theory of Einstein (relativity theory). In a non-dispersive medium both the propagation velocities of the particular wave as well as the wave group will be the same, $v_g = v_p$.

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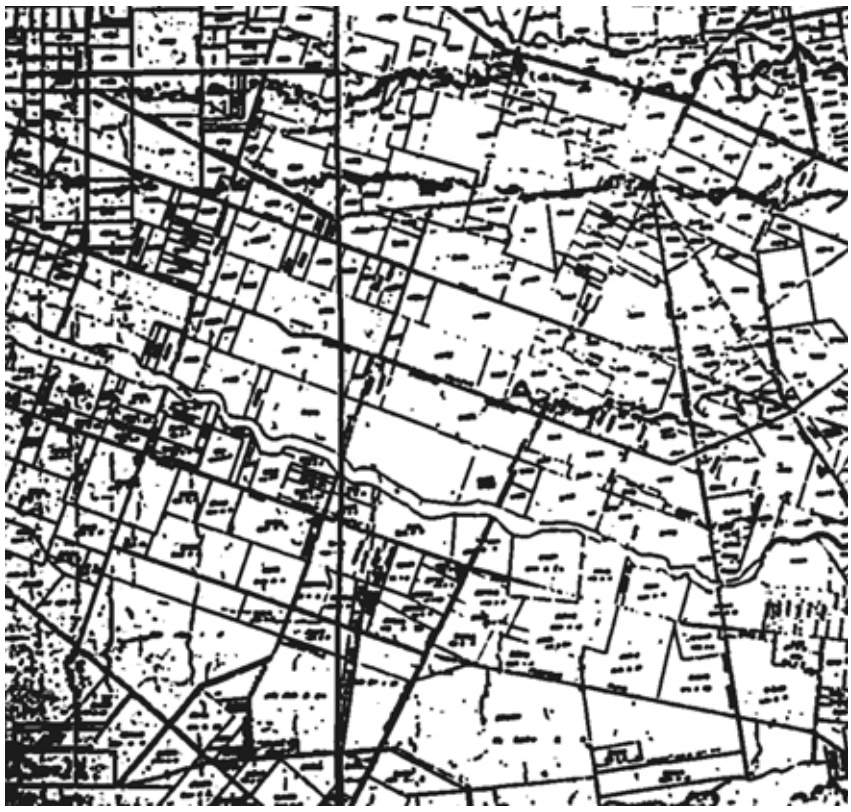
The Coordinates Class room espouse readers to graticules of Mathematics and Physics that epitomize the Geospatial Information Technology. A chain of structured presentations related to interdisciplinary principles that define Geodesy, GPS, GIS, Geospatial data management and Image processing are to be en suite in this section in each issue of the Coordinates. Initially the chain trembles with Geodesy which is the mother of technologies to position the Coordinates.

Positioning the cadastral maps in LIS

We need a system of efficient maintenance of land records which is essential for protection of land rights of several millions of people in the country

DR IV MURALI KRISHNA

The three prime entities that are involved in the maintenance of Land information system (LIS) are the Department of Revenue, Department of Survey, Settlement and Land Records, and Office of land registration. In addition to this, the appropriate municipal or village administrative unit is also involved. This is the convention in many states in India. The land records in India, do not provide ultimate title to property. In other words we need a system of efficient maintenance of land records which is essential for protection of land rights of several millions of people in the country. Land has been one of the most sought after possessions in developing countries such as ours, wherein, the land holding has socio economic significance and status. Thus there is a need to develop an integrated LIS. A lot can be said and discussed about various activities and issues that are being dealt to create a LIS in different parts of the country. There are some success stories in Karnataka and some efforts of Governments in the states of Andhra Pradesh, Gujarat and Madhya Pradesh. The importance has been recognized and limitations of the current system are understood at various levels. . In all these success stories there is a systematic implementation and addressing of local issues and sentiments. As such development of an integrated LIS cannot be viewed as just putting all the information in digital form and designing a front end or a typical GUI for user interaction by availing services of few IT experts or MNCs. In fact the Land management in our country is purely Indian way and it has legacies of history and no imitation or service of prime MNCs or international bodies has relevance or use or significance for our country. The basic issues related to data particularly the cadastral maps in terms of micro level components, macro level components, logical consistency and lineage need to be addressed in detail. The technology for land management should be professionally precise following the principles of surveying. Ideally it should also be socially acceptable and economically viable.



Cadastral map and LIS

Out of several issues an updated cadastral map, graphical information of the parcel with exact co-ordinates of the corners of the field and extent of the field and attribute information about land use, soil type, details of crops and ownership are the most sought after details of any LIS. The scale of the map, creation of ground control points, density of parcels and topography of the area are the key factors to be considered in relating the cadastral map and LIS development. The identification and establishment / measurement of ground control points is essential for the accurate creation or maintenance of cadastral maps. There are several case studies involving the conventional ground surveying methods, conjunctive utilization of conventional surveying tools and GPS, aerial photography and satellite

imagery. These are in the form of operational applications, technique development programs as well as research projects. One of the essential requirements of the cadastral survey is the satisfaction of the property owner. Hence the re-survey methodology must provide for the faster handling and disposal of the disputed cases, together with the citizen satisfaction. In the context of requirements of the products / information, detailed assessment of the tasks / tools involved in cadastral mapping is to be carried out. A partial assessment is carried out in this paper which addresses only one or two issues related to updating of cadastral map and geo referencing. These are related to role of high resolution data for cadastral map updating and utilization of GPS /DGPS data in post processing and real time processing modes.

Role of high resolution satellite imagery

The very high resolution data from IKONOS, CARTOSAT and QUICKBIRD is available with resolutions of 1 meter, 2.5 meters and 0.60 meters respectively. What are the implications of resolution for mapping and the accuracy? A satellite image with about 2.5 meters resolution is found to have planimetric accuracy better than 6.5 meters after precision processing based on a systematic study and accuracy estimation. In the same study the one meter data is found to provide 3 meters accuracy. As such the direct applicability or relevance of satellite data for cadastral level mapping need to be understood properly. Here, there are in fact three parameters that are found to be relevant and need to be understood. The first parameter is the resolution of the sensor which is understood by every one as it is given under the specifications of the sensors. The second parameter is related to the ground resolved distance which is the size of the smallest object detected on the image. For example the LISS III data with 23 meters resolution shows the railway track. Does this mean that the objects of size 1 to 2 meters can be mapped using LISS III data. It is possible only when we are interested in identification of certain long thin features that exhibit high contrast with their background. The third parameter is related to planimetric accuracy. This is concerned with mapping the features in two dimensional domain and it is found to be a combined result of spectral and spatial discernability. Two different sensors operating in VNIR region each with 80 meters or 23 meters spatial resolution but with different spectral bandwidth and channel allocations are found to provide different accuracies. It is found that the spectral discernability also plays a significant role in delineating the features and thus influencing the mapping accuracy. The significance of contrast as an influence on spatial resolution illustrates the interrelationships between the various forms of resolution and emphasizes the reality that no single element of system resolution can be considered in isolation from others. This is where the influence of mixed pixels comes into accuracy delineation. It is interesting to examine the relationships between the number of mixed pixels in a given scene and the spatial resolution of the sensor. It is found that the percentage of mixed pixels is low for high spatial resolution images. The shape of an object feature is significant. Aspect ratio is ratio of length to width. For long thin features like roads, railway tracks etc the aspect ratio is a very high non dimensional parameter. These features are seen on satellite images even though the resolution is more than the size of the feature. As such it can be concluded at this stage that a careful evaluation of different tools and data sources is required for taking up any step related to enhancing the value of the existing cadastral maps which are on 1 to 4000 or 8000 scale. We should keep in mind the accuracies that are feasible and level of details that are to be identified for land record maintenance. Obviously it should be stated that the high resolution remote sensing data available as on today from different sensors has potential only for thematic mapping and limited utility for cadastral mapping or updating. Let us in all fairness do not hesitate to conclude that high resolution satellite data is not useful in planning, design and implementation of LIS. The only alternative is to go for aerial photography or ALT survey on scales between 1: 6000 to 1: 10,000. Aerial photos where ever available can provide 1 to 4000 scale cadastral maps. The accuracy here is about 40 cm considering 20 microns on the aerial photo negative with 1 to 10,000 scale. Areas requiring survey or resurvey need to go for this as no other method can substitute these efforts to provide the desired accuracies for delineating land parcels The usage of the final cadastral maps using the photographic images or the satellite images is also very limited as the legal boundaries of holdings cannot be determined from the photographs without extensive checking on the ground. In all cadastral surveys there is a need for follow-up ground surveys to check the actual location of legal boundaries that may not be visible on the photographs or may have been wrongly identified. One of the great disadvantages of aerial or satellite survey is that, except for the ground control marks that are part of the basic control network or framework, it does not leave permanently demarcated points on the ground.

DGPS – Technology

The second aspect is related to the application of GPS in differential mode. For areas with reasonable cadastral map availability, the major task of maintaining land records and creation of Land information system can be based on DGPS surveys which can provide scope for georeferencing of the cadastral maps This is possible in post processing mode or real time operation mode. The effort required for post processing mode is more

than 10 times the effort required for real time processing mode. It is essential to fix the most important feature namely the "control point" i.e., bi or tri-junctions (point where boundaries of villages meet) as well as other identifiable points. Presently cadastral maps do not contain information about the height. As such height information can also be incorporated in DGPS stations. This will lead to 3d cadastral mapping in due course of time. DGPS can provide accuracies better than 50 cm to the control points. This is adequate for cadastral surveys. On a map of 1 to 4000 cadastral map the smallest feature that can be mapped is of 80 cm or say 1 meter size. So the accuracy is far more than the minimum mappable unit on 1 to 4000 scale which is in fact the major satisfying feature. There is a need to create local reference frames or grids which can be used for GPS survey by triangulation or grid methods. It may be noted that the first and second order points built under the CARTOSAT utilization projects by Department of Space, Government of India, all over the country are very useful for the purpose of establishing control points or control grid and traverse running. Access to this information is limited and possibly requires approval and clearance by Government.

Preparation of the georeferenced digital cadastral map

This is essential task of the entire ILIS and basic issue. How to go about it. With out much introduction and explanation to the problem it can be stated based on studies in different situations, DGPS in real time operation mode is a better option or solution for this problem. It is not going to provide the solution on a turn key mode. This has only scope and need to be calibrated. This will help us to draw a road map for digital cadastral map creation with minimum of the resurvey task. The cadastral record information with reference to parcel numbers is to be identified with the help of land records and related government officers. This is a very crucial stage of the creation of ILIS. How to geo reference the parcel boundaries. Also these are to be put under a standard reference system like WGS 84 system. It is the major issue. Several techniques of updating / resurveying are being proposed. These include aerial triangulation, use of total station and GPS/DGPS, satellite image processing etc. A detailed analysis and understanding of the potential of the technology suggest that a RTK GPS (It is a DGPS with real time processing capabilities) based surveying of selected points or boundary points and calibration is "the technological tool" for this task in the present context. The experience with RTK was successful in retrieving the control points and the method was accurate for planimetric applications and is several times faster than traditional methods. Generally there are some conditions which to become aware of to obtain a satisfying accuracy by using RTK. There must be contact to a good number of satellites and PDOP has to be low which indicates good satellite geometry. To apply the RTK method in cadastral surveys it is necessary that the basic point has a high horizontal accuracy, whereas it is sufficient for the determination of the z-coordinate to use a height from a topographical map (the accuracy of the contour lines is about 1 m in topographical maps of scale 1:25.000). A brief account of the achievable accuracies using DGPS is given in Table 1. It is possible to use the GPS method RTK for cadastral surveys. The accuracy of the parcel coordinates is proportional to the number of ground control points used for calibration of GPS and georeferencing. The value of the cadastral maps in such a situation will be enhanced significantly, because every measurement on the map is in a referred coordinate system. In conclusion it can be stated that the Cadastral map based LIS must follow also a standardized data format and prepare a protocol of accuracies so that uniformity is maintained all over the country.

Type	Achievable Accuracies
Planimetric Accuracy	The DGPS - RTK method affords high absolute accuracy,. Taken together the evaluation is that the DGPS - RTK method - considering the accuracy - can replace other methods of measuring in the cadastral surveys - and in tasks which require the same accuracy
Height Measurement	DGPS -RTK method does not give a vertical accuracy, which can be used for all sorts of leveling tasks, where the conventional tools are used. Particularly where the requirement is at cm-level the DGPS RTK method is found to give problems.

Table 1 The accuracies achievable using DGPS

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Dubai Municipality launches three-dimensional Dubai guide

Dubai Municipality has recently developed an electronic, three-dimensional guide for the Emirate of Dubai for the purpose of government departments and private sector establishments. According to Mohammed Al Zaffine, Director of the municipality's GIS Centre which oversaw the guide's preparation in cooperation with French Concept Digital Solutions, a private firm, the guide would offer 3-D modelling of the whole emirate of Dubai. He added that the guide would offer an interactive 3-dimentional view of the emirate of Dubai and a virtual movement within the emirate is also possible. Visitors can easily find addresses in the emirate and they can spot registered companies and obtain their telephone numbers. Contributing companies can also display their services and products in the guide, in addition to hotels, shopping malls and other tourist landmarks. *www.ameinfo.com*

Yemen Agricultural Atlas completed

A team of agricultural experts have completed the first volume of a complete survey of agricultural areas in Yemen. The volume, the first of its kind in Yemen, focuses on agricultural production, natural resources, soil, vegetation, arable land, cereals, fruits, nuts and livestock such as camels, cows, goats and bees. According to the President of the Agricultural Research Organization, Ismael Muharram, the volume is a summary of a collection of studies carried out by the GIS and the Remote Sensing Center. This agricultural atlas is of a special importance to the policy makers. The organization intends to make a comprehensive record of plants that exist in Yemen. *www.yobserver.com*

BMC in India may turn to GIS during calamities

The Brihanmumbai Municipal Corporation of Mumbai in India is interested in introducing GIS for dealing with any future calamities like the devastating rains on July 26. The BMC officials present are interested and have asked the ESRI to give them a blueprint on how GIS can be set up in the city. The ESRI officials, however, could not respond to this immediately as they said implementation of GIS may last from a few months to several years. The cost of implementation and maintenance also differs for various projects. *http://economictimes.indiatimes.com*

Heritage map of Srinagar launched

Srinagar a 1600 year old city of Kashmir in India achieved a milestone on 20th September, when its first heritage map compiled by the Centre for Heritage and Environment Kasmir (CHEK) was launched by Chief Minister Mufti Mohammad Sayeed. The five volume cultural resource mapping, completed in collaboration with Indian National Trust for Art and Cultural Heritage (INTACH), gives Srinagar the distiction of being the second city in India after Delhi with a documented map on heritage structures. The map of Srinagar is much improvised in the sense of latest technology used in it. The full documentation of this resource mapping includes architectural features, the dangers and probable use. *www.hinduonnet.com*

Nairobi city council project in doubt

A project by the Nairobi City Council in Kenya to raise Ksh8 billion ($104m) annually in rates from an estimated 500,000 properties and parcels of land in the city is now in doubt following a government crackdown on surveyors it accuses of using data obtained unlawfully. Under the project, which the World Bank is financing through the International Development Association, the cash-strapped council had contracted Geomap Africa Ltd, a leading land surveying firm to identify and log all rateable properties in the city into a GIS. This would have made it possible for City Hall to identify and zone all land parcels in the capital and come up with an updated property index which it would use to collect rates.

According to a document prepared by the council's Assistant Town Clerk, P M Kamau, City Hall currently collects revenue from only 100,000 ratable properties compared to the more than 300,000 recorded by the Director of Surveys and the Commissioner of Lands. This gives the council only an estimated Ksh1.2 billion ($15.5m), which it claims is not enough to clear garbage, repair the city's potholed roads, provide street lights, ensure continued water supply, improve its rundown schools and clinics and clear illegal developments. But whether the project will now progress has been put in doubt by a new order by the Director of Survey, Kombo Mwero banning surveyors from using government-owned databases and maps in private projects. *www.nationmedia.com*

Aid agency uses GIS to fight hunger in Africa

Aid agency 'Concern' has received a donation from ESRI Ireland for 30 copies of their product ArcView. Using GIS Concern can map and assess the vulnerability of areas where it provides aid. ArcView allows the agency to have a spatial understanding of the nutrition and food security vulnerabilities in the areas of work. This allows them to plan their interventions in areas of greatest need. 'Concern' is currently piloting the GIS software in several countries in Africa including Malawi, Democratic Republic of Congo (DRC) and Niger. *www.reliefweb.int*

GIS map of Sabah's coral reefs produced

A map on the distribution of coral reefs in waters off Sabah's 1,600-km coastline in Malaysia has been produced after more than a year's work. It is available in GIS format at the Town and Regional Planning Department. The map will allow the department to develop specific policies and regulations to classify land use at coastal zones, and can also provide information to researchers and others who want to know about coral reef distribution. It was produced by the department, Universiti Malaysia Sabah, the World Resources Institute (WRI) and an 11-agency Integrated Coastal Zone Management working group. *www.nst.com.my*

National agencies in U.K. build e-learning repository

Higher education funding agencies in Ireland and the UK have joined forces to further the development of e-learning in third level educational institutes. At a recent meeting in Dublin, the Higher Education Authority (HEA) and the UK's Joint Information Services Committee signed a memorandum of co-operation that will see the agencies sharing knowledge, ideas, experience and possibly content as well. The agreement is seen to be a significant boost to the development of the recently established National Digital Repository -- which draws together existing digital images, maps, pieces of film and audio, texts, simulations and other multimedia elements in one resource for use by academics and students. The repository, which is expected to be in use by the end of next year, consists of a digital learning resource repository together with a small set of tools to facilitate easy population of and retrieval from the storage area. *www.enn.ie*

UK Police and local authorities put criminals on the map

The UK's fight against crime is turning to computer based maps in order to pinpoint criminal behaviour more effectively. Crime & Disorder Reduction Partnerships (CDRPs) in areas including West Midlands, Barking & Dagenham, Newcastle, Nottingham and South Yorkshire are now using a software Crime Analyst from ESRI (UK), to make data mapping and analysis a more mainstream weapon against criminal behaviour. Crime Analyst helps crime fighting by creating reliable crime maps of geographical areas in minutes, uncovering crime patterns, like journey to crime, repeat offences, time of crime and geographical hotspots and reducing the time taken to compare and link similar offences. *http://sourcewire.com*

Surrey Police upgrades IT at its non-emergency contact centre

Surrey Police is upgrading the IT at its non-emergency contact centre. The system from Intergraph Corporation delivers an intranet mapping system that spatially displays a variety of community information and police intelligence to assist contact centre operators who deal with calls from the public. Approximately 200 contact centre operators have constant, around-the-clock access to the map-based information.

International Symposium on GPS/GNSS 2005

Hong Kong 8-10 December 2005

The Department of Land Surveying and Geo-Informatics (LSGI) at the Hong Kong Polytechnic University will host the International Symposium on GPS/GNSS from 8th to 10th December 2005. It is the fourth of a series of the largest international symposium in the Asia-Pacific region dedicated to satellite-based positioning technology and applications.

In addition to the normal symposium activities, the International Information Committee of the US Civil GPS Service Interface Committee (CGSIC) will organize an information session on GNSS developments.

The symposium is open to all aspects of GPS/GNSS research, development, and application:

GPS modernization and Galileo development, New algorithms and techniques on satellite positioning, GPS/GNSS environment monitoring (ionosphere, water vapour), GPS/GNSS for land, marine and air applications, and Other GNSS related research areas.

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Forest cover change in Andaman and Nicobar islands

The damage from last December's tsunami has been counted in the Andaman and Nicobar islands and it is huge. The islands' forest cover has taken a big hit, marine life has been badly affected and some famous beaches have vanished. India's Ministry of Environment and Forests report says the tsunami has badly devastated the islands' ecosystem. Conducted post-tsunami by ISRO through satellite mapping and released recently, the study found forest depletion of up to 27 per cent in islands like Nancowry and Trinkat. In the Nicobar group of islands, 12,224 hectares of forest cover was lost. Comorta, Nancowry and Katchal saw major coral reef erosion. The report says in some places the entire coral reef area suffered. Satellite images showed that the mangrove trees facing the waves were the worst hit. Extensive areas have turned barren or have been totally eroded in the tsunami's wake. Some major beaches — big tourist attractions — have almost disappeared. The Noncowry and Trinkat beaches in the Nicobar group of islands have vanished. What remains are just barren rocks. Officials say it will take years for new beaches to be carved out from the sea. Marine life, too, has been hit hard. The nesting beaches in the Nicobar group of islands have almost vanished as the islands have gone under the sea by one to three metres. *www.hindustantimes.com*

Maps to prepare Malaysia for future tsunami

Maps will provide the key to limiting the physical and human toll on the nation in the event of another tsunami. The Malaysian Centre For Remote Sensing is on the verge of completing a mapping exercise that will prepare the nation in the event of another such disaster. The first phase, completed in June, will help authorities in terms of damage assessment. By early next year, the second phase to help identify areas that may be affected in the event of another tsunami will be completed. The first phase was completed in June using data from satellite images of the Dec 26 tsunami on how far the water travelled inland. The maps will help authorities identify areas to be evacuated, prepare early warnings, identify locations for relief centres and initiate public awareness programmes. *www.nst.com.my*

New coastal remote sensing network along East China Sea

Shanghai Fishery University will team up with the US National Oceanic Atmospheric Administration to create a coastal remote sensor network that will monitor fishery resources and forecast natural disasters in the East China Sea. The network, China CoastWatch, is a satellite system that collects real-time basic data about the ocean environment - such as water temperatures, tide directions and wind velocity - and transfer it to a ground receiving station for analysis. Researchers say the information will help them make conclusions about ocean resources along the coast, including fish migration routes, and predict typhoons and other climate phenomena. http://english.eastday.com

Satellite data shows grim picture of Arctic ice melt

The Arctic ice shelf has melted for the fourth straight year to its smallest area in a century, driven by rising temperatures that appear linked to a buildup of greenhouse gases. Scientists at NASA and the National Snow and Ice Data Center, which have monitored the ice via satellites since 1978, reported that the total Arctic ice in 2005 will cover the smallest area since they started measuring. It is the least amount of Arctic ice in at least a century, according to both the satellite data and shipping data going back many more years, according to a report from the groups. As of September 21, the Arctic sea ice area had dropped to 2.05 million square miles, the report said. *http://epaper.timesofindia.com*

NASA technology monitors wildlife habitats from the air

Two rare species, California spotted owls in the Sierra Nevada and the Delmarva fox squirrel in the mid-Atlantic U.S. have something in common. Using NASA technology, scientists have been able to identify habitats to help forest managers monitor and protect these species and other wildlife. The recent research shows that airborne laser scanning with Light Detecting And Ranging (LiDAR) can be especially valuable in ensuring that forests and other lands continue to be diverse, healthy, and productive, while still meeting the needs of society and the environment. *www.sciencedaily.com*

NOAA Aerial Mapping assisting in Hurricane Katrina

The NOAA Office of Response and Restoration is working closely with FEMA and the U.S. Coast Guard in coordinating the response to hazardous materials in the flood waters of New Orleans and with the continuing search and rescue mission in response to the aftermath of Hurricane Katrina. One of the innovative technologies being applied is combining LIDAR and aerial satellite imagery to create aerial maps of the region. NOAA is assisting in tracking the progress in removing water from the flooded areas of the region by providing aerial maps showing the progress to date. The maps are generated using satellite imagery acquired from the Department of Defense National Geospatial Intelligence Agency combined with LIDAR (Light Detection and Ranging) data from Louisiana State University and the State of Louisiana. Research Planning Inc., a NOAA contractor, is conducting this synthesis that shows likely water depths based on the combination of data. These maps show the progress in removing floodwaters from New Orleans following Hurricane Katrina by comparing water levels on August 31 and September 8. *www.noaanews.noaa.gov*

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After Y2K concerns, where are we with our calendar?

The Gregorian Calendar (GC) is in satisfactory alignment for centuries to come. As per the per rules for leap years, there will not be any possibility of February to be of 30 days in the present calendar

MUNEENDRA KUMAR, PH.D.

Our Calendar

The Tropical or Mean Solar year consists of 365.24219879 mean solar days (dM) in which the Earth goes round the Sun. We use mean year and days as the actual year and days are not constant in their duration or they both fluctuate. The length of the Tropical Year (TY) is measured by the time interval between successive appearances of the Sun in the vernal equinox.

Historical Irony

For about 16 centuries, our calendar was based on the fundamentally wrong assumption that the Sun goes round the Earth. When Galileo found that the "reverse" is the truth, one Pope forced him to retract from the reality and it took more than three centuries before another Pope declared Galileo as one of the greatest scientists of all times.

Interesting Rivalry between 2 Caesars

We start with all the "trouble" the calendar designers had to take for compensating the fractional day in the number "365.24219879" and making the TY easily usable in practice.

Julius Caesar started the Julian Calendar (JC) from 46 BC. However, the Roman Senate set 1 January as the starting day of the calendar while he wanted a day in March. July (named after Julius Caser) was set to have 31 days and August to 30 days. He fixed February to be of 29 days in the common non-leap year and to 30 days in a leap year. Julius Caesar's untimely death created confusion and it seems that this resulted in a three-year leap cycle instead of four.

Augustus Caesar, who succeeded Julius Caesar, took measures to set the JC right. He changed February to 28 and August (named after him) to 31 days, i.e., to be equal in days as July. Augustus reset the leap year cycle to four years and thus, he can be credited with bringing the JC to its final form by 4 AD. He designated the Julian Year (JY) to be of 365.25 dM. Thus, in its final form as set by Augustus Caesar, the JC started accumulating an extra day due to the difference of 0.0078 dM between the TY and JY every about 128 years.

First Council of Nicea

The "extra" 0.0078 days eventually began to cause problems for the early Roman Catholic Church. The Easter religious holiday was set by the Church to occur at or near the vernal equinox in order to predict the calendar date of Easter for future years. However, the accumulation of "extra" days was moving the calendar date of the vernal equinox itself. The Council of Nicea, now Iznik in Turkey, then decided that the Easter was to be related to the current date (at that time) of the vernal equinox. The Church therefore established 21 March as the date to be used for the religious observation of the vernal equinox despite any astronomical observations. This practice led to the drift in the interval of days between the "official" religious vernal equinox (21 March) and the actual occurrence of the vernal equinox by about one day every 128 years. Presumably, the Council compensated the "extra" two days, which had accumulated in the JC up to 325 AD.

Efforts of Friar Roger Bacon

In or about 1267, Friar Roger Bacon dispatched a strident missive to Pope Clement IV requesting that the JC require a correction. Friar Bacon was ignored, denounced, and even imprisoned for his calculated correction. Bacon's effort was about two centuries ahead of time in light of the reforms that were introduced by Pope Gregory in 1582.

Gregorian Calendar

Realizing that the error in the JC was causing the Easter to shift away from the vernal equinox, Pope Gregory III in 1582 proposed the next set of correction to the civil calendar in use. The recommendations of his calendar commission were put into practice by many catholic countries. His first major action was to drop 10 days from the Gregorian Calendar (GC), i.e., the day after October 4 was designated as October 15, 1582.

The GC was then set to 365.2425 dM with a new rule that a century year not divisible by 400 was not to be a leap year. Thus, the years "1700", "1800", "1900", "2100", etc., will have only 28 days in the month of February like other normal years. Other years "2000", "2400", "2800", etc., will be leap years

Pope Gregory set the GC closer to the actual TY as compared to the JC.

International Terrestrial Reference Frame (ITRF)

The International Terrestrial Reference Frame (ITRF) "yy" is a realization of the International Terrestrial Reference System (ITRS), where the "yy" represents the year of the solutions. Since its first realization in 1988, there have been many variations and additions in use of data types and changes in computational strategy.

International Earth Rotational Service (IERS), successor to Bureau International de L' Heure (BIH), Paris, France, has so far performed 10 solutions for the years 88, 89, 90, 91, 92, 93, 94, 96, 97, and 00. But, in the 10 solutions, IERS has realized only three reference frames for the three Reference Epochs (RE):

ITRFyy	RE
ITRF88, ITRF89, ITRF90, ITRF91, ITRF92, and ITRF93	88.0
ITRF94 and ITRF96	93.0
ITRF97 and ITRF00	97.0

Note:

1. "ITRFyy" without the reference epoch (nn.0) does NOT completely identify the "ITRF".
2. ITRF88 to ITRF93 were realized for the same RE (88.0) and thus, these six solutions realize the same "ITRF". There is no geodetic validity in a 7-parameter transformation between them.
3. ITRFyy (nn.0) does not constitute a geodetic system by itself. It is an accurate realization of the Earth's "TRF" for the specified reference epoch. This is available for defining and establishing national, regional, continental, and/or world geodetic system.
4. When the ITRFyy (nn.0) is used to define and establish a geodetic system, the RE "nn.0" does not change, as the defining "RF" remains the same; only the time epoch of the GPS network adjustment is attributed to the newly adjusted geodetic system.

Important Consideration: The three IERS realized "ITRF (88.0, ITRF (93.0), and ITRF (97.0)" are defined consistent to the BIH realized Conventional Terrestrial System (CTS), Epoch 84.0. But, the users should note that these four "RFs" have different origin and orientation.

Clarifications:

1. The origin is at the Earth's center of mass.
2. The reference meridian is a new realization. It is not to be associated to the old longitude of the telescope of the Greenwich Observatory.
3. The ITRFyy (nn.0) is NOT based on the International Association of Geodesy (IAG) defined Geodetic Reference System (GRS) 1980.
4. ITRFyy is NOT a vertical datum.

Muneendra Kumar, Ph.D.
Research Consultant

However, his realignment still left an over compensation of 0.0003 dM (about 2 hours 53 minutes) per year or 0.12 dM per 400 years.

Second Look at Gregorian Reform

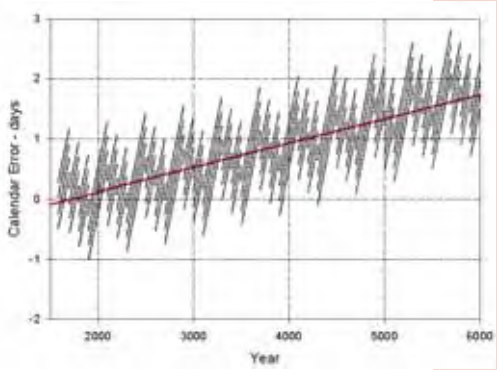
We see here that the correction of 0.0078 dM causes the JC to gain one dM about every 128 years and thus in 1582 it would have been ahead by about 12+ days counting from 4 AD, the year JC attained its final form under Augustus. However, to correct this error in JC, Pope only dropped 10 days to designate the day after October 4 as October 15. It seems that Pope Gregory gave full credence to the decision of the First Council of Nicea where the correction for 1257 years, from 325 to 1582 AD, would be 10 days approximately. Here, it is interesting to note that in 1923, the Eastern Orthodox Churches corrected the two-day error, which Pope Gregory did not, to render the JC more accurate. They designated October 1 1923 as October 14 1923 in the Eastern Orthodox calendar.

A Recent Simulated Study

Figure 1 shows that the difference

between the GC and the actual TY will keep growing over the coming centuries.

Figure 1. Difference between GC and TY from Y2K to Y6K



Here, simple computations show that the GC has accumulated 0.12 dM by Y2K and would differ by one dM around 4900. To compensate for this, the year 4800 AD is not to be a leap year, even though it is divisible by 400. Thus, the Gregory's current rule would require a finer tuning or modification. However, computer simulation (Figure 1) shows that the total accumulation may reach to one dM around 4000 AD (or Y4K). If this comparison trend continues (as per the simulation), the year 4000 AD or Y4K will be a non-leap year.

Possibility of 30 Days in February

The 30-day February in the Y2K was a debated possibility in India and a few other countries. If we review the overcompensation of the present GC and the simulation over the coming centuries, it clearly shows that a 30-day February was not possible in Y2K. It will also not occur for any year and any time in the coming centuries.

Recommendations

The alignment to start the year on 1 January, though set arbitrarily by the Roman Senate, and to relate the Easter with the vernal equinox by the First Council of Nicea are already established conventions for centuries. To even consider making any modification would only result in unnecessary confusion. The Gregorian Calendar (GC) is in satisfactory alignment for centuries to come. As per the per rules for leap years, there will not be any possibility of February to be of 30 days in the present calendar. However, the GC would require a finer tuning its 400-year rule and the century year Y4K in the fourth millennium, even though divisible by 400, will be a non-leap year.

Measuring Time-Invariant Sea Floor Depths

For safe sailing, two most important requirements are to be able to determine clearances (1) between the sea floor and the keel of the ship, and (2) between the mainmast and overhead structures, such as cables and bridges. For these clearances, the mariner has to know correctly and accurately the following:

1. Location of the sea floor or ocean depth,
2. Height of the overhead structure,
3. Locations of the ship's keel and mainmast.

For centuries and even in the present practice, the above four surveyed positions are referenced to more than one datum. Further more, these datums, tidal and/or predicted astronomical, take long period of time to establish and then are time-dependent and time-variant. While underway, when a mariner really needs anyone of the datums, they are not available, as their zero(s) have changed.

Now, in an innovative approach, the four positions are measured and two clearances are computed with respect to the time-invariant ellipsoidal surface as zero reference. Then, the mariners would have them correctly and accurately in one datum, whenever required. In shallow waters and inside harbors, the captain of a ship will be able to compute the clearances accurately and with confidence to avoid grounding or striking overhead obstructions, such as bridges and cables.

Combining GPS surveys and acoustic soundings, highly accurate ellipsoidal depths of the sea floor can be established in new areas or by filling gaps. In separate GPS surveys, the ellipsoidal heights for overhead structures can also be determined. The time-invariant sea floor depths and heights of the overhead structures can then be stored in the Marine Information System (MIS) database for future use. While underway in shallow waters, in berthing, in approaching channels, and inside a harbor, using a mainmast-mounted GPS antenna and the ship's general arrangement drawings, the shipboard computer will determine the positions of the ship's keel, mainmast, and Plimsoll marks. Then, recovering the already established sea floor depths and heights of overhead structures, it can compute the two clearances for safe navigation.

And, all the above is possible without any reference to the time-variant tides, tidal and/or predicted astronomic datum(s), mean sea level, geoid, and ship's draft.

Muneendra Kumar, Ph.D.
Research Consultant

COORDINATES will publish the paper by Dr Muneendra Kumar and Prof George Maul on this 21st century innovative approach. – Editor.

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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.

Israeli MATIMOP becomes a member of GJU

The Executive Director of the Galileo Joint Undertaking (GJU) Mr. Rainer Grohe and the Director of the Israeli MATIMOP Mr. Yair Amitay, signed the Agreement in Jerusalem, whereby MATIMOP becomes a member of the GJU. The signing ceremony was hosted by the Israeli Vice-Prime Minister, Mr. Ehud Olmert. Rainer Grohe: "I am very pleased that MATIMOP is now a member of the Galileo Joint Undertaking. Israel has performed great achievements in space technology. I am certain that the participation of Israeli entities will contribute significantly to the overall success of the Galileo Programme. Israeli and European industries will mutually benefit from their experiences." MATIMOP is a non profit organisation, under the Ministry of Industry, Trade and Labor, which promotes technological and R&D cooperation and technology transfer activities between Israeli and foreign industries.

The GJU was set up in 2002 by the European Union (EU) and the European Space Agency (ESA) to manage the development phase of Galileo - the European global satellite navigation programme. MATIMOP has committed to contribute EUR 18 million to the GJU, for activities in the development phase of the Galileo Program. The Israeli side will participate to the development phase with their own technical contribution. *http://europa.eu.int/comm/dgs/energy_transport/galileo*

Chinese Company Bids for Galileo Operation Franchise

A Chinese state-controlled company announced that it will bid for the operation franchise of the Galileo Project in China.

Meng Bo, chair of the board of China Galileo Industries (CGI) Ltd., said, "We're trying to get the operation franchise in China,which might begin in 2008."

CGI, a joint venture owned by China Aerospace Science and Technology Corporation, China Electronics Technology Group Corporation, China Satcom and China Academy of Space Technology, was designated by the European Union (EU) as the Chinese partner on the Galileo Project.

The operation franchise plan helps ensure profits made from the money-consuming Galileo Project, costing 3.5 billion euros in research and satellite network deployment.

October 2005

56th International Astronautical Congress
16-21 October Fukuoka, Japan

International Property Valuation Conference
16-20 October, Hong Kong
info@hkis.org.hk

Short Term Course on Airborne Altimetric LiDAR
17 October - 20 October 2005
Kanpur India
lidar@iitk.ac.in
http://home.iitk.ac.in/~blohani

9th Int. Symposium on Physical Measurements and Signatures in Remote Sensing
17 - 19 October 2005, Beijing, China
liurg@lreis.ac.cn
http://www.ISPMSRS2005.org

Trimble Dimensions 2005 User Conference
23 - 26 October, Las Vegas, USA
rhonda_heninger@trimble.com
http://www.trimbleevents.com

Asia and Pacific Region Socet Set Users Conference;
24-26 Oct Cairns; Australia
rob.coorey@baesystems.com

MEDCOAST 2005 (7th International Conference on the Mediterranean Coastal Environment)
25-29 October Kusadasi, Turkey

GEOINT 2005
October 30-November 2, 2005
San Antonio, TX USA
http://www.geoint2004.com

AfricaGIS 2005
30 October - 4 November 2005
Pretoria, South Africa
fduplessis@openspatial.co.za
http://www.africagis2005.org.za

November 2005

AGI 2005
1- 3 Nov, Chelsea Village, London
angela.mcmahon@agi.org.uk
http://www.agi2005.org.uk

OZRI 2005
2-3 November Gold Coast, Australia
ozri@esriaustralia.com.au

The 12th world congress of the Intelligent Transportation Society (ITS).
6 - 10, 2005 San Francisco,
CA, United States
http://www.itsworldcongress.org

ACRS 2005
7- 11 Nov, Vietnam, Hanoi
eisa.ig@fpt.vn
http://www.acrs2005.ac.vn

International Conference: "Earth Observation foaterr vegetation monitoring and water management"
10-11 November Naples, Italy
durso@unina.it

10th Internatonal GIS Seminar in Korea, 14-15 November 2005,
Seoul Education & Culture
Center, Seoul, Korea
junghkim@krihs.re.kr

Qatar GIS Conference & Exhibition 2005
14 -16 Nov, Qatar, Doha
info@gisqatar.com
http://www.gisqatar.com

7th Gulf Water Conference - Water in the GCC - Towards an Integrated Water Resources Management (IWRM)
19-23 November Kuwait
gwater7@kisr.edu.kw

First National GIS Symposium in Saudi Arabia
21 November - 23 November 2005
Eastern Provice,Saudi Arabia
http://www.saudigis.org

South East Asian Survey Congress
21 - 25 Nov , Brunei
secretarygeneral@seasc2005.org.bn
http://www.seasc2005.org.bn/congven.html

GEO-INFO Congres
23 - 25 November 2005
Amsterdam, The Netherlands
info@geo-info.nl
http://www.geo-info.nl

25th International Cartographic Congress
28 Nov – 1st Dec 2005Sagar, M.P. India
rkt_sagar@hotmail.com,
inca25_sagar@yahoo.com
www.incaindia.com

Short term course on "GPS Surveying"
28 November - 2 December 2005
IIT ,Roorkee
gjkumfce@iitr.ernet.in

Navigation 2005
30 Nov-1 Dec, The Hilton, San Jose, CA
www.telematicsupdate.com/navigation2005
register@telematicsupdate.com

2nd International Conference 'Earth from Space'
30 Nov - 2 Dec, Moscow, Russia
http://www.transparentworld.ru/conference/

December 2005

First International Symposium on Health GIS
1 - 2 Dec, Bangkok, Thailand
healthgis@gmail.com

Middle East and Africa Conference for ESRI Users 2005
6 – 8 Dec 2005
meauc2005@qs4it.com
www.qs4it.com/meauc2005

ISPRS Workshop On Spatial Planning & Decision Support **Systems**
8-10 December Macres,
Kualalumpur Malaysia

25th ISRS Annual Convention and National Symposium
6 - 9 December 2005
secretary@isrs2005.org
http://www.isrs2005.org

42nd Annual Convention and Meeting of the IGU
Earth system processes related to earthquakes,
tsunamis and volcanic eruptions Back
7-9 Dec 2005,India, Bhopal
ak_gwal@yahoo.co.in
http://www.igu.in/schedule.htm

GNSS 2005
8 – 10 Dec, Hong Kong, China
lswuchen@polyu.edu.hk
http://www.lsgi.polyu.edu.hk/GNSS2005

Gulf Traffic - GIS Zone
12 - 14 December, Dubai UAE
davyd.farrell@iirme.com
http://www.gulftraffic.com

ITC 55 years Lustrum Conference
14 - 16 Dec 2005
The Netherlands, Enschede
verburg@itc.nl
http://www.itc.nl/news_events

January 2006

First Asia-Pacific Conference for ESRI Users
January 12-13, 2006 · Hong Kong, China
http://www.esrichina-hk.com/apuc2006/

International Symposium: Informatics for Geoinformatics
23-25 January 2006 Ostrava,
Czech Republic
www-gis@vsb.cz.

Regional GBIF training workshop for Southeast Asia
25-27 January 2006.
Lucknow, India
www.gbif.org.

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Dr. Scott Pace, Associate Administrator for Program Analysis and Evaluation, NASA HQ, Washington, DC. May 11, 2005

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