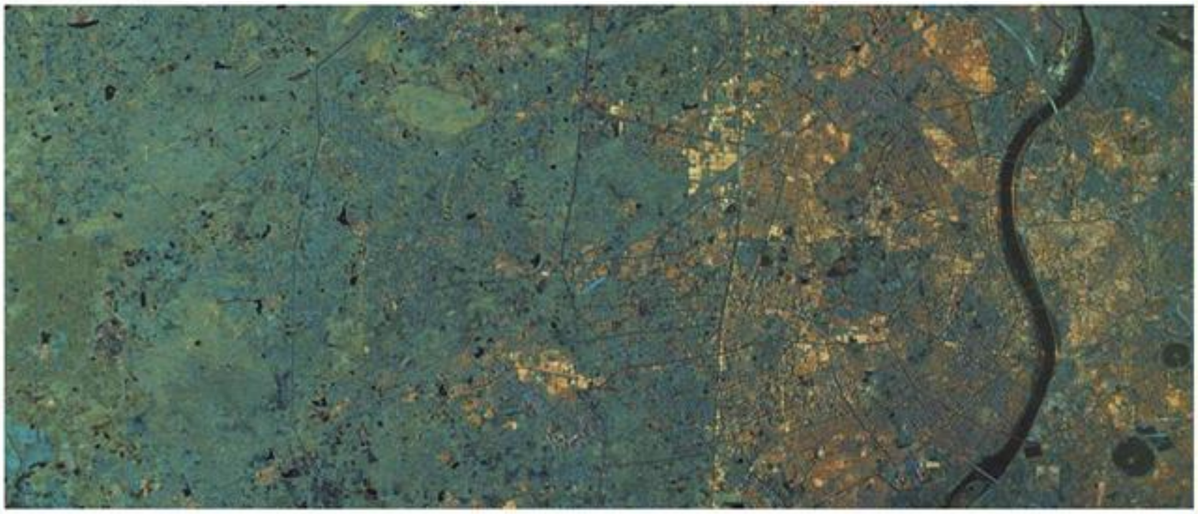
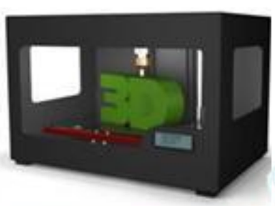
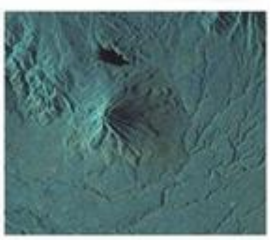
ISRS

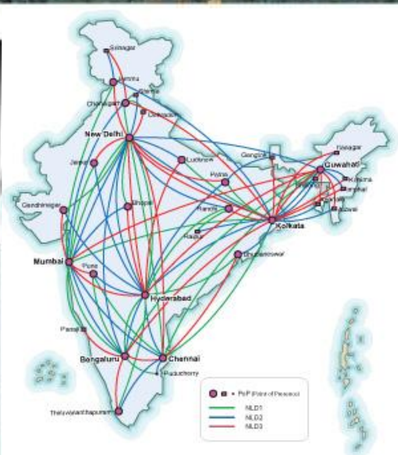
Signatures

Newsletter of the Indian Society of Remote Sensing- Ahmedabad Chapter

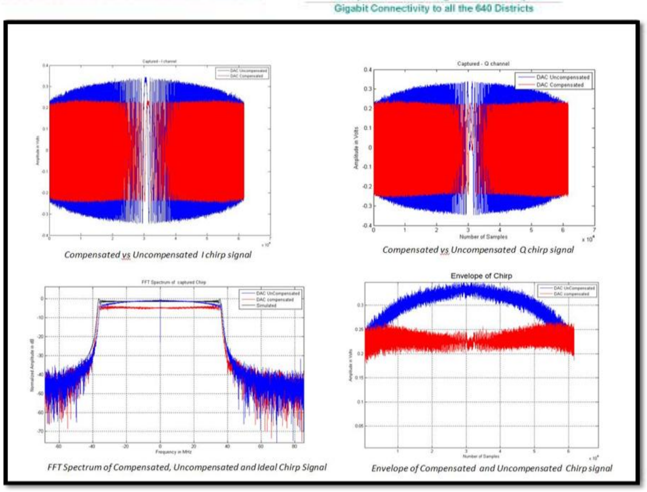








Multiple 10G Connecting all the State Capitals
Gigabit Connectivity to all the 640 Districts



Compensated vs Uncompensated I chirp signal

Compensated vs Uncompensated Q chirp signal

FFT Spectrum of Compensated, Uncompensated and Ideal Chirp Signal

Envelope of Compensated and Uncompensated Chirp signal

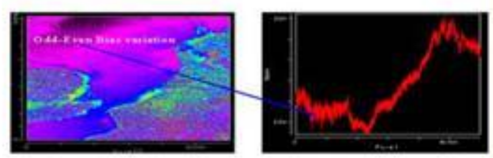


Figure-1: Radiometrically Corrected B2 AWiFS and Full Profile

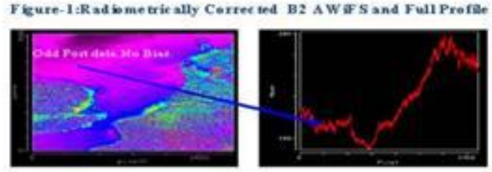


Figure-2: Odd Port data and Full Profile

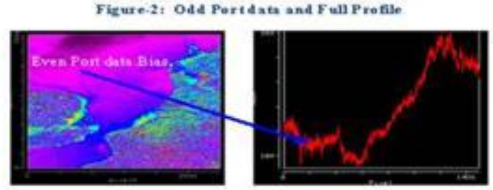


Figure-3: Even Port data and Full Profile

ISRS

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Newsletter of the Indian Society of Remote Sensing,
Ahmedabad Chapter Volume: 25, No.3, October 2013- March 2014

INSIDE THIS ISSUE

S i g n a t u r e s

Newsletter of the Indian Society of Remote Sensing-Ahmedabad Chapter, *Oct'13-Mar'14*

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From Chairman's Desk

Dear Readers,

As you all know, during the past few years, theme based Newsletter-Signatures have been brought out, which have been well appreciated by the ISRS-AC readers. The positive feedback coming from the members and some of the valued readers is truly heartening. The Signatures editorial team has done an excellent job by working in harmony with the ISRS-AC EC team to evolve themes of significance and current interest.

This particular issue is a general newsletter, having a few articles which have been contributed by our enthusiastic readers. This shows that even if we do not announce a theme based issue, many scientists would like to contribute their scientific ideas, as is expected in such a class of magazine. I thank them all for their support. I am extremely grateful to Ms Arundhati Misra, the Editor of Signatures, who along with her team, has been relentlessly working towards making this issue different from the earlier theme based issues. This issue also contains some new ideas with cartoon, quiz and more scientific news from all across the world. I hope the readers will appreciate this effort.

The executive committee has completed its tenure of two years in March 2014. The team has performed its goal very effectively by organising various events like Pisharoty Memorial lectures, NRS day celebration, World Environment Day celebration etc. I take this opportunity to whole heartedly extend my gratitude and appreciation for the team as well as the ISRS members. I also sincerely thank ISRS-AC for giving me the opportunity to be chairman of the chapter and all the cooperation thereafter.

With this I conclude by giving my heartiest congratulations to the editorial team. Best wishes to all the readers and my best regards to all the members

D Subrahmanyam

Chairman, ISRS-AC

SPECIAL ACHIEVEMENTS

Sri AS Kiran Kumar, Director, SAC receiving the Padmashri award from the Honourable President of India

ISRS-AC would like to take this opportunity to congratulate Sri A S Kiran Kumar for this great achievement

National Knowledge Network

Dr. Haresh Bhatt

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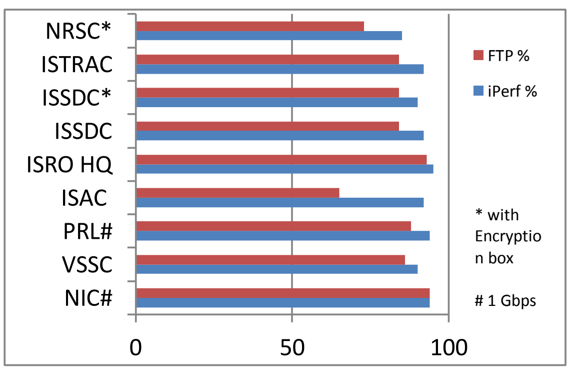
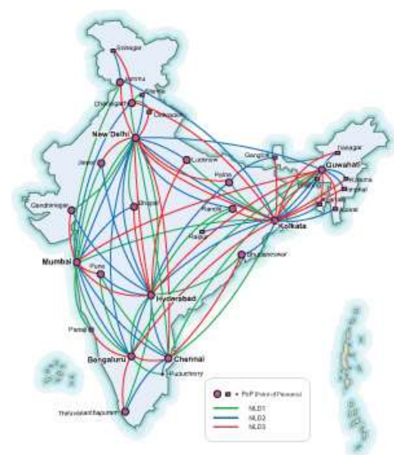
The key to successful research today demands live consultations, data sharing and resource sharing. National Knowledge Commission has established National Knowledge Network (NKN) to provide high bandwidth network with well defined QoS for information exchange and collaboration. Space Applications Centre is having 1Gbps NKN connectivity since last few years. SAC users are using the same for Internet surfing since long. Now 21 ISRO centres are connected to NKN which gives us opportunity for its effective utilization.



SAC had taken initiatives to carry out thorough performance testing to exploring its utilization in intern centre data communication. SAC and ISSDC, NRSC characterization was carried using ADRIN encryption box while others were unencrypted. Rigorous testing was carried out for 30-45 days with 10 samples on 3 sessions of each day. NKN connectivity has been found reliable throughout the testing of 45 days. Unencrypted bandwidth was found to be 90 % whereas encrypted bandwidth was 5% less as expected. This gave us confidence in using NKN for our operational data communication among the centres.

Subsequently, SAC had taken initiatives to form ISRO-VRF (Virtual Private Network) for ISRO centres for private data communication. ISRO HQ has taken initiatives to provide additional encryption box to all centre to move our current 2 Mbps MPLS spacenet to 100/1000 Mbps NKN. Meanwhile, filesharing service is offered to projects and entities for data communication with other ISRO centres. User can use the SAC FTP server to host the data to share with other ISRO centres, user other centres FTP server to download the data and/or host FTP service within own lab for data exchange.

These file sharing service is just initiatives towards effective utilization of NKN. More value added services like high speed, high quality, multi point video conference, inter centre library exchange, COWAA information exchange, compute resource utilization among centres, license & application utilization among the centre, etc can be thought of and realized.



Multiple 10G Connecting all the State Capitals
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Users are welcomed to put up proposal on such collaborative applications and services.

There are more than 1000 other government and academic institutes connected on NKN. IMD, IITs, CSIR labs, TIFR, BARC, DRDO, etc are few important collaborative organization. Users may explore possibility of collaborative information exchange with them and put up proposals for the same.

IMPROVEMENT OF RADIOMETRIC QUALITY USING BI-LATERAL FILTER

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Abstract: In the case of passive remote sensing systems, the Sun is the sole source of energy. The position of the Sun relative to the Earth varies during the day. Moreover different objects reflect solar irradiance according to their individual spectral and physical properties. The recorded value of radiance from the Earth surface by remote sensing observations are affected by a number of electronic, geometric, mechanical, and radiometric distortions that, if left uncorrected, would diminish the accuracy of the information extracted and thereby reduce the utility of the data. Now before applying the correction approaches it is very much required to assess the anomaly properly.

In case of push broom optical sensor, generally imaging is done using linear/area array of CCD/CMOS at the focal plane of the optics. Depending on the need of the Mission, Mono or Multi-spectral data is acquired. Quantization level varies based on the requirements for radiometric performance of the mission.

During realization of instrument, radiometric characterization of sensors is carried out in laboratory not only to establish the transfer function (DN to Radiance) of the sensors, but also to characterize all observed anomalies which are having impact on the radiometric quality of the video data. Though absolute radiometric characterization during ground Light Transfer Characteristics (LTC) exercise of sensors is carried out methodically but depending on the sensitivity of the sensor some anomalies (Odd/Even detector bias, Module imbalance etc.) varies randomly. Because of randomness, mere periodic updation of radiometric Look-up-table won't suffice the characterization of radiometric quality to provide the required level of accuracy in data.

In Resourcesat-2 LTC exercise, odd/even detector bias was observed in AWiFS sensor data (Band2-Band4) and characterized as fixed pattern bias using the knowledge of the odd/even bias of LTC data.

Introduction: The pre-requisite for quantitative radiometry is the absolute radiometric calibration of the sensor, which links the recorded digital numbers to physical units. The major benefit of a radiometrically calibrated sensor is the possibility to radiometrically correct images from atmospheric effects to surface reflectance.

After launch, during the course of the mission life, it is required to monitor the different aspects of the sensor as per the mission specifications. Detection and rectification of radiometric anomalies in time helps to provide assurance of reliable radiometric quality of the digital data products.

From the analysis of Light transfer characteristics (LTC) data of AWiFS instruments, it was observed that the Odd-Even detectors are having inherent characteristics of bias variation. The Odd-Even difference shows that non-linearity presents in the Even channel, which is not getting adjusted even after PRNU (Photo Response Non Uniformity) correction applying higher order polynomials. The presence of this Odd-Even bias ([1]) incurs striping in the data. During the pre-launch radiometric calibration phase using LTC data of AWiFS sensor, fixed bias file for even detectors is computed for each band.
Before the application of radiometric look-up-table this flat file of lab data bias is used to remove the bias effect.

After launch it is observed that depending on the intensity of the illumination and the resulting reflectance spectra from the surface of a scene the odd-even bias pattern varies randomly.

Radiometrically corrected on-orbit data of Resourcesat-2 AWiFS sensor shows an overall scene based non systematic residual bias even after the needed odd-even fixed bias adjustment (Fig. 1), Splitting of odd (Fig 2) and even (Fig 3) port data shows that only even port data is having residual bias which is resulting in fine stripping.

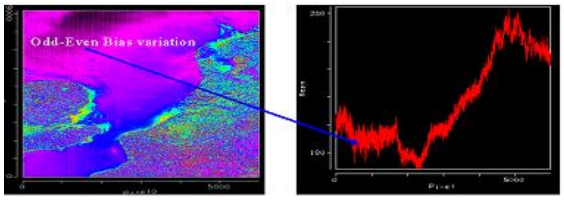


Figure-1:Radiometrically Corrected B2 AWiFS and Full Profile

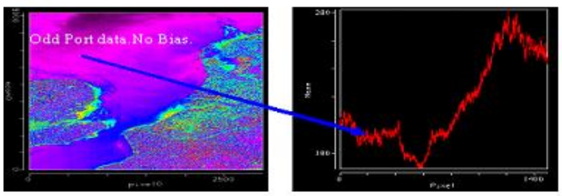


Figure-2: Odd Port data and Full Profile

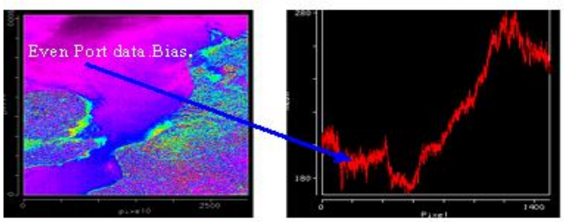


Figure-3: Even Port data and Full Profile

It is observed that even after application of updated Odd-Even bias file (using the bias variation of different terrain of on-orbit data), the AWiFS sensor data retains some residue bias Fig-1,2,3). These residue biases are resulting as fine stripping in the image. To remove those fine stripping radiometric correction beyond radiometric Look-up-table becomes a necessity.

Methodology: To remove this residual bias, a method is designed and developed. The implemented method is tested for AWiFS data of Camera A and B and results are shown. It is observed from the results that the fine stripping are reduced to a greater extent and also preserves the size, edges and contrast of the features.

Combining the statistical method [2] along with the bilateral filter [3] a procedure is designed to have a capability to deal with nonlinear detector responses of AWiFS sensor. Determination of residual bias of the even port at the lower limit of the scene dynamic range is done automatically from histograms of even and odd channels. Then for each pixel, DN value is compared with the surrounding kernel radius matrix cells to find the appropriate similarity. Each pixel value is analyzed using the neighbouring pixels behaviour and replaced by a weighted average of the pixels in a local neighbourhood; the weights depend on both the spatial distance and the intensity difference. In this process, edges are preserved well while noise is averaged out. Formula at a pixel location x is as follows

$$I_x = 1/C_x \sum_{y \in S} a(y-x)\, b(v_y - v_x)\, v_y \qquad (1)$$

$$I_x = 1/C_x \otimes W v_y$$

$$\text{Where } C_x = \sum_{y \in S} a(y-x)\, b(v_y - v_x)$$

S =All neighboring pixels coordinate of the matrix cell under the kernel radius.

I_x = Resulting pixel intensity.

v_y, v_x=Intensities of pixels at y and x location.

a(y-x)=Geometric distance between y and x coordinate.

b(y-x)=Intensity similarity between pixels at y and x location is the combination of Spatial Domain and Range weighting which is applied on the current pixel value to get the updated value using the similarity of the pixels of the neighboring cells, where Domain weighting and Range weighting are given below as

Spatial Domain weighting:

$$a(y-x) = e^{-\frac{d(y-x)^2}{2\sigma_d^2}},$$

The Euclidean distance between y and x is

$$d(y-x) = |y-x| = \sqrt{y^2 + x^2}\,.$$

Range weighting:

$$b(v_y - v_x) = e^{-\frac{\delta(v_y - v_x)^2}{2\sigma_r^2}},$$

$\delta(v_y - v_x)$ = Intensity difference between two pixels.

As a pixel influencing another pixel not only reside at nearby cell of the matrix under kernel radius but also possess a very similar value. Residual bias adjustment of the even detectors for water body regions depending on the image histogram along with the application of the bilateral filter for overall image removes the fine striping keeping the image sharpness and feature contrast as original image.

Applications and Observations: From the above specified image of AWiFS-A band2 data and its full profile it is observed that the odd-even bias variation (Fig-1) is mainly because of the bias of even detectors (Fig-3) compared to the corresponding odd detectors (Fig-2).Combined response of odd-even detectors on the same image is resulting as fine stripping. Results of the implementation of the specified methodology is shown in Fig-4,5,6 with PSNR. ROI based analysis is also shown in Fig-7.

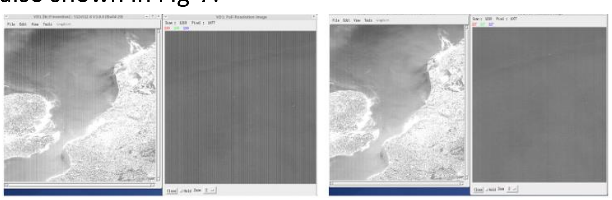


Figure-4: Original Data with Residual Bias **Modified Data without Bias (PSNR: 64.04)**

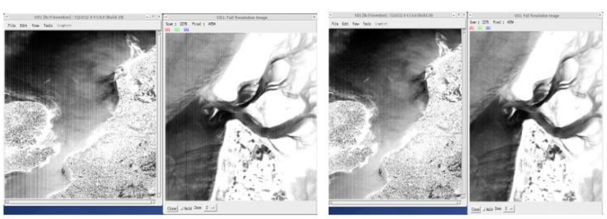


Figure-5: Data with Residual Bias **Modified Data without Bias (PSNR: 64.04)**

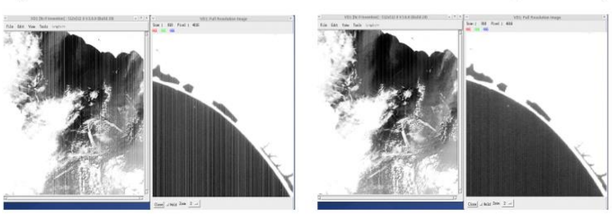


Figure-6: Data with Residual Bias **Modified Data without Bias (PSNR : 54.18)**

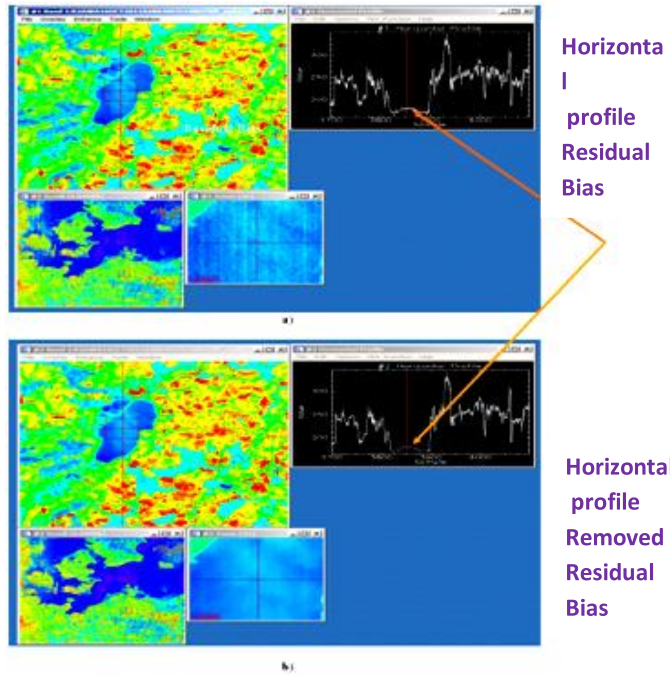


Figure 7: a) Original Data and b) Modified Data with Profile

Results and Discussions: In images acquired by linear CCD array of detectors in Push-broom sensor, each detector represents a particular column. Inherent Odd-Even detector (column) bias which is observed in LTC exercise is absorbed in the radiometric Look-up-table generation procedure, but still some non-uniform detector bias remains (even columns are not always brighter than odd columns which are the results of the non-uniform detector gains. Here in a random fashion, bright/dark fine vertical striping can be observed in even columns as a result of non-uniform random bias).

This remaining Odd-Even residual bias difference of 2-5 count results in a very fine striping which can be observed when the image is hard-stretched (12 bit data in 5-6 bit dynamic range). To provide more fidelity of the information of the observed scene surface a combination of statistical method along with the application of bilateral filter is applied to removes/reduces the fine striping depending on the available suitable intensity of the kernel.

A kernel is build with local information in order to remove the striping. This is a non-linear filter which smoothes the image without smoothing across the edges. Kernels of the Bi-lateral filter depends on two important factors

I. The degree of edge preservation.

II. The spatial scale of the filter which depends on the spatial extent of the kernel. The spatial kernels are selected to be radially symmetric. The spatial extent sets the size of the structures to be preserved or removed without any blurring and artifacts.

Using this methodology, the Odd-Even residual bias is characterized by replacing each pixel with a weighted average of its neighbours in a very useful and effective way. It makes it easy to acquire perception about its behaviour considering the neighbours' behaviour depending only on above said two parameters that actually indicate the size and contrast of the features to preserve.

This approach takes into account the difference in value with the neighbours keeping into account that for a pixel to influence another pixel, it should not only occupy a nearby location but also have a similar value.

In our analysis and discussion we have omitted the date of acquisition, path/row such specific information intentionally. This methodology can be used for any digital image de-noising purpose which has the above described striping. We have focused on the phenomena of residual bias and its implication on image as very fine striping.

References:

[1]"Pre-Launch Radiometric Characterization of Resourcesat-2 AWiFS-A &AWiFS-B Using Clean Room Light Transfer characteristics Data", SAC/SIPA/DPSG/TN-08/ May-2010

[2]Statistical Linear Destriping of Satellite-Based Pushbroom-Type Images, Hervé Carfantan, Member, IEEE, and Jérôme Idier.

[3]M. Aleksic, M. Smirnov, and S. Goma, "Novel bilateral filter approach: Image noise reduction with sharpening," in Proceedings of the Digital Photography II Conference, volume 6069, SPIE, 2006.

Acronyms:

CCD: Charged Coupled Device
CMOS: Complementary Metal Oxide Semiconductor
DN: Digital Number
PSNR: Peak Signal to Noise Ratio
LTC: Light Transfer Characteristics
AWiFS: Advanced Wide Field Sensor

The Opposition of Mars

Earth and Mars are converging for a close encounter. As March gives way to April, the distance between the two planets is shrinking by about 300 km every minute. When the convergence ends in mid-April, the gulf between Earth and Mars will have narrowed to only 92 million km--a small number on the vast scale of the solar system.

Astronomers call this event an "opposition of Mars" because Mars and the Sun are on opposite sides of the sky. Mars rises in the east at sunset, and soars almost overhead at midnight, shining burnt-orange almost 10 times brighter than a 1st magnitude star

FUN TIME

Puzzle 1:

A farmer wants to cross a river and take with him a wolf, a goat, and a cabbage. There is a boat that can fit himself plus either the wolf, the goat, or the cabbage. If the wolf and the goat are alone on one shore, the wolf will eat the goat. If the goat and the cabbage are alone on the shore, the goat will eat the cabbage.

How can the farmer bring the wolf, the goat, and the cabbage across the river?

Puzzle 2:

Find a 10-digit number where the first digit is how many zeros in the number, the second digit is how many 1s in the number etc. until the tenth digit which is how many 9s in the number.

Puzzle 3:

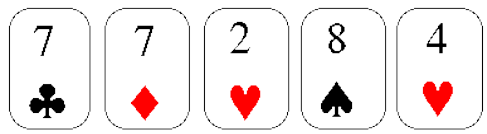
When asked about his birthday, a man said:

"The day before yesterday I was only 25 and next year I will turn 28."

This is true only one day in a year - when was he born?

Puzzle 4:

I am thinking of one of these five cards:



You have to try to find out which one I am thinking of. Here are some clues:

i) The value of my card is a prime number.

ii) The values of my two neighbours add up to a multiple of 3.

iii) My card is next to a card which is next to the 2 of hearts.

Puzzle 5:

Find a number with its letters in alphabetical order.

Example: "five" has "fiv" in alphabetical order, but not "e".

Solution to Puzzle 1:

Farmer takes Goat across (leaving Wolf and Cabbage behind)
Farmer returns alone
Farmer takes Wolf across
Farmer returns with Goat

* We now have the Farmer, the Cabbage and the Goat on one side and the Wolf on the other side

Farmer takes Cabbage across
Farmer returns alone
Farmer takes Goat across

Solution to Puzzle 2:

6210001000

Solution to Puzzle 3:

He was born on December 31st and spoke about it on January 1st.

Solution to Puzzle 4:

I was thinking of one of the five cards in the picture. You had to try to find out which one I was thinking of. It was the TWO OF HEARTS.

This is how to find out from the clues:

i) The value of my card is a prime number.
So it could have been 7C or 7D or 2H.

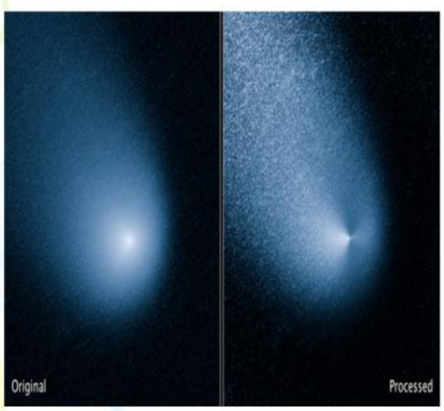
ii) The values of my two neighbours add up to a multiple of 3.
So it could have been 7D or 2H.

iii) My card is next to a card which is next to the 2 of hearts.
So it could only have been 2H.

Solution to Puzzle 5:

Forty

Hubble sees Mars-bound comet sprout multiple jets



Left: This is a Hubble Space Telescope picture of comet C/2013 A1 Siding Spring as observed on March 11, 2014. At that time the comet was 353 million miles from Earth. The solid icy nucleus is too small to be resolved by Hubble, but it lies at the center of a dust cloud, called a coma, that is roughly 12,000 miles across in this image. Right: When the glow of the coma is subtracted through image processing, which incorporates a smooth model of the coma's light distribution

Credit: NASA, ESA, and J.-Y. Li (Planetary Science Institute

A new image of a comet at 353 million miles from Earth shows two jets of dust coming off the comet's nucleus in opposite directions.

Microwave Domain Remote Sensing Sensors: ISRO Perspective

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Introduction: Microwave remote sensing(MRS) has been gaining importance in the whole world during the last four decades. It is worth mentioning that ISRO had its fair share of experience in this field right from the mid 1970s. However, microwave remote sensing program development, with its all weather and day-night operation capability had a longer gestation period compared to its optical brethren, because of the requirement of complex hardware technology development, infrastructure building and complex processing algorithms designing. Over the last 3 decades MRS programme evolved into two basic paths of applications namely Imaging and Non Imaging (Atmospheric and Oceanographic) applications. This article is meant for a brief fly-through the major microwave remote sensing sensor development and related activities at SAC.

Non Imaging Sensors: First development of microwave sensors was started in SAC during the mid 70s.

SAMIR onboard BHASKARA: Three frequency satellite microwave radiometer (SAMIR) was developed and successfully flown onboard BHASKARA– 1&2 satellites. SAMIR provided the first glimpse of global columnar water vapour and liquid water content. Bhaskara was a spin stabilized satellite and SAMIR was configured as a vertically scanning radiometer. This had a Dicke configuration, and scan view of the open sky was used for cold calibration input. It provided a footprint of 150-250 km resolution with a sensitivity of 1-2K.Bhaskara satellites had two spinning modes namely around roll axis or pitch axis. In the first mode of spin, SAMIR provided a swath of 1500 km from 777 km altitude. In second mode of spin, in every scan it provided single sample of measurement at nadir.

MSMR Onboard Oceansat-I:
Multi-frequency Scanning Microwave Radiometer (MSMR) was flown onboard Oceansat-I (IRS-P4) satellite. This was ISRO's first microwave remote sensing satellite dedicated for oceanographic applications. The satellite was launched in 1999.This radiometerwas a four-frequency, dual-polarised scanning microwave radiometer with a Dicke configuration. This radiometer system had a very intricate and well designed on board calibration system. The pre launch on ground calibration technique development using BBT(Black Body Targets) was the first of its kind in ISRO.

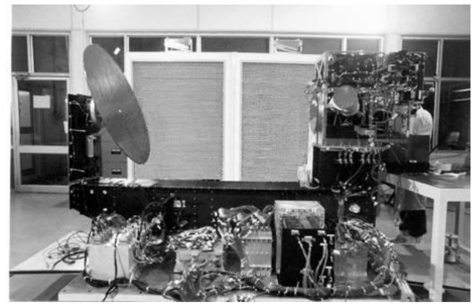


Fig 1: MSMR in clean room

This was needed for achieving the required brightness temperature accuracy of about 1.5K. The brightness temperature data sets derived from this sensor were used for deriving geo-physical parameters like sea surface temperature (SST), surface wind speed, integrated water vapour and liquid water content, etc. The software for generating routine operational products providing antenna temperatures, gridded brightness temperatures, gridded geophysical parameters was developed at SAC and transferred to NRSA.

Cherry Picker:
A ground based scatterometer (Cherry picker) was developed to carry out signature studies as a function of frequency, polarization and look angles. The operating frequency was 1-18 GHz.

Megha-Tropiques Related Development:

Megha-Tropiques mission was a joint Indo-French collaboration between ISRO and CNES. This mission has four radiometers on board, with three in the microwave bands. This mission was conceived to study the tropical atmosphere for climate and atmospheric research and for meteorological applications. The highly inclined orbit of MT, of 20^0 provide observations of the ITCZ(Inter Tropical Convergence Zone) at high repetivity. The microwave payloads in this satellite are:

a. MADRAS (Microwave Analysis And Detection Of Rain And Atmospheric Structures)- Imaging microwave radiometer 18.7,23.8, 36.5, 89 to 157 GHz (5 Frequencies and 9 channels)
b. SAPHIR (Sondeur Atmospherique du Profil d'Humidite Intertropicale par Radiometrie) - Sounder for Atmospheric Profiling of Humidity in the Inter-tropics by Radiometry (6 Channels Around 183.31 GHz)
c. Radio Occultation System -ROSA

The Back-End Electronics (MBE) hardware unit for MADRAS was designed and developed at SAC while the scan mechanism was developed at IISU. Its antenna and RF hardware were designed and developed by CNES and ASTRIUM, France. Both MADRAS and SAPHIR are configured as Total Power Radiometers(TPR). MADRAS has a conical scanning around the vertical axis, to obtain a swath of about 1700Km. SAPHIR has a cross track scan in order get a swath of about 1700Km. Except MADRAS, all other payloads were designed and developed by CNES, France. The operational data processing software for all the payloads were designed and developed at SAC. MT was successfully launched on 12th October 2011 from SHAR.

Ku-band Scatterometer on-board Oceansat-II:

A Ku-band Scatterometer (13.5GHz) was developed at SAC and it was launched on board the Oceansat-II satellite in 2009. This system provides calibrated sigma-nought values over a swath of around 1400Km from an altitude of about 720Km, with dual polarization modes of VV and HH. The swath is obtained by the conical scanning around the vertical axis. The calibrated scattering coefficients obtained from this sensor, are used to derive near surface wind vectors over oceans at a global level. The scatterometer wind field measurements form a very important input to the global weather forecasting system. This Ku band scatterometer system was the first spaceborne radar system of ISRO .

Fig2: Integrated Scat Payload at integration lab, SAC

MM-Wave Sensor Development:

Simulation and design of two separate mm-wave sounding units on a space-borne platform, was taken up at SAC, since 2006. TSU (Temperature Sounding Unit) is designed to measure the atmospheric temperature profile up to an altitude of 40Km, using 13 channels in the 50-60GHz zone. The HSU (Humidity Sounding Unit), is designed to measure the humidity profile upto an altitude of about 10Km, using 5 channels around the water vapour absorption frequency of 183.31GHz.

Two more surface correction channels at 23.8 and 31.5GHz are also present in the TSU. Similarly, for the HSU, the surface correction channel at 89GHz is provided. From an altitude of 725Km, a swath of around 1550Km will be obtained. The nominal footprint size for the TSU is around 40Km, while that of HSU is around 10Km. Initially the 2 units were designed to fly on the same satellite on an IMS-II bus. As of today, the 2 units are now to be flown on separate satellites. These are proposed to be launched during 2015-16 time frames. Being in the mm-wave band, the technological challenges in fabrication and testing are much more compared to the microwave bands. The design and fabrication of the on board black body target (BBT) for calibration is another challenging task here. The schematic diagram of TSU on the IMS bus is shown below.

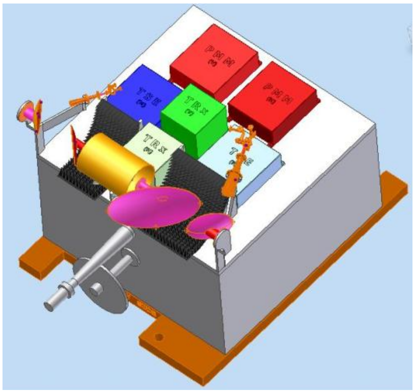


Figure 3: TSU Schematic Diagram

Imaging Sensors:

Although the first microwave payload developed in SAC was a non imaging sensor (SAMIR), work in the field of imaging sensor development was taken up during 1980s and SLAR was ready to be flown in 1985.

X Band SLAR:

In the field of imaging sensor development, airborne X band SLAR (Side Looking Airborne Radar) was designed, developed and flown in a Dakota, DC-10 aircraft. Several test flights took place during 1986 over Ahmedabad, Surat, Ajmer etc. It is to be noted that this was the first radar sensor developed at SAC. The operating frequency was 9.6GHz, and it was operated at an altitude of 3Km to give a swath of about 5Km. This provided the first breakthrough in the radar sensor development.

C Band ASAR and DMSAR:

The SLAR was followed by the development of C band airborne SAR sensor which had various modes of image acquisition from small to large incidence angles, from an altitude of 8Km. The ASAR system had the unique feature of a DACS(Dynamic Antenna Control and Stabilization system) developed by IISU, Trivandrum. This was the first attempt at motion sensing and motion compensation, which are very crucial in the case of airborne SAR system. Good quality processed images were produced using advanced techniques of processor design around an indigenous super-computer system - PARAM having 32 Transputers. This was the first airborne SAR processor developed in the country, although the first spaceborne SAR processor was developed by SAC, way back in 1987 for the L band SEASAT, followed by an operational SAR processor for ERS-1, in 1991.

Figure 4: X Band SLAR and image

Figure5: C Band DMSAR system

The airborne SAR, ASAR was augmented to DMSAR (Disaster Management SAR) system(C band) with a high resolution capability mode of about 1m. Swath width of about 60Km at a reduced resolution of 10m is also present. This system has advanced features of IGS (integrated INS and GPS) to accurately sense the motion related errors. However the motion correction is done on ground through a complex processing algorithm. DMSAR was truly the precursor to the C band RISAT system.

RISAT:

RISAT is the first spaceborne synthetic aperture radar sensor for ISRO, developed completely indigenously. This sensor has the capability to image the earth's surface in various modes. The uniqueness of this mission was the development of state of the art electronics. The active phased array antenna system was the first of its kind in the country. Another unique feature was the inclusion of hybrid polarimetric SAR mode of operation, which is the first time for an EOS mission. Apart from this a unique concept of sliding Spotlight SAR mode, was also incorporated.

RISAT has the unique capability to work in all possible modes of data acquisition, viz. Stripmap, Spotlight, Scansar, Quad polarization and also Hybrid polarimetry, giving the users a wide choice of application data sets. RISAT was successfully launched on 26th April, 2012.

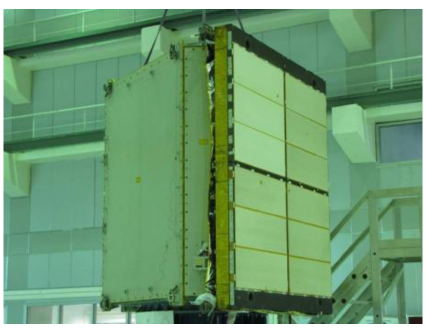


Fig6: C Band RISAT panel after integration

FUTURE MW SENSORS:

With the success and experience of microwave remote sensing technology development, and high quality processing and application products, more microwave projects are being proposed. SAR sensors in L, S, and X band are coming up in the near future. Chandrayan-II will be carrying dual frequency SAR system with L and S band. A joint NASA-ISRO collaboration for a project named NISAR, having advanced SAR technology of dual frequency S and L band using digital beam forming technique, is also in the offing.

Similarly, in the field of non-imaging sensors, Scatt-II, having the same sensor specification as the Scatt-I, is being developed for a launch in 2015.

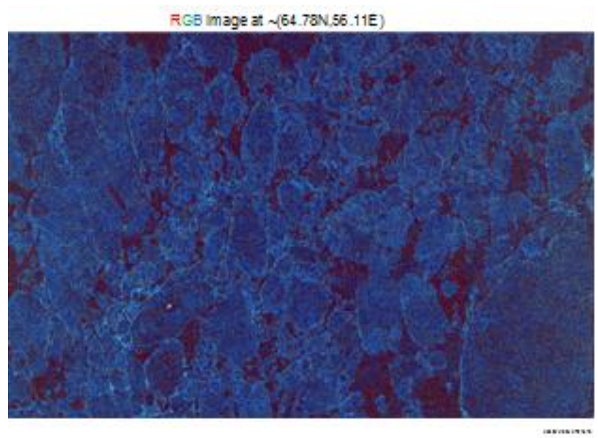
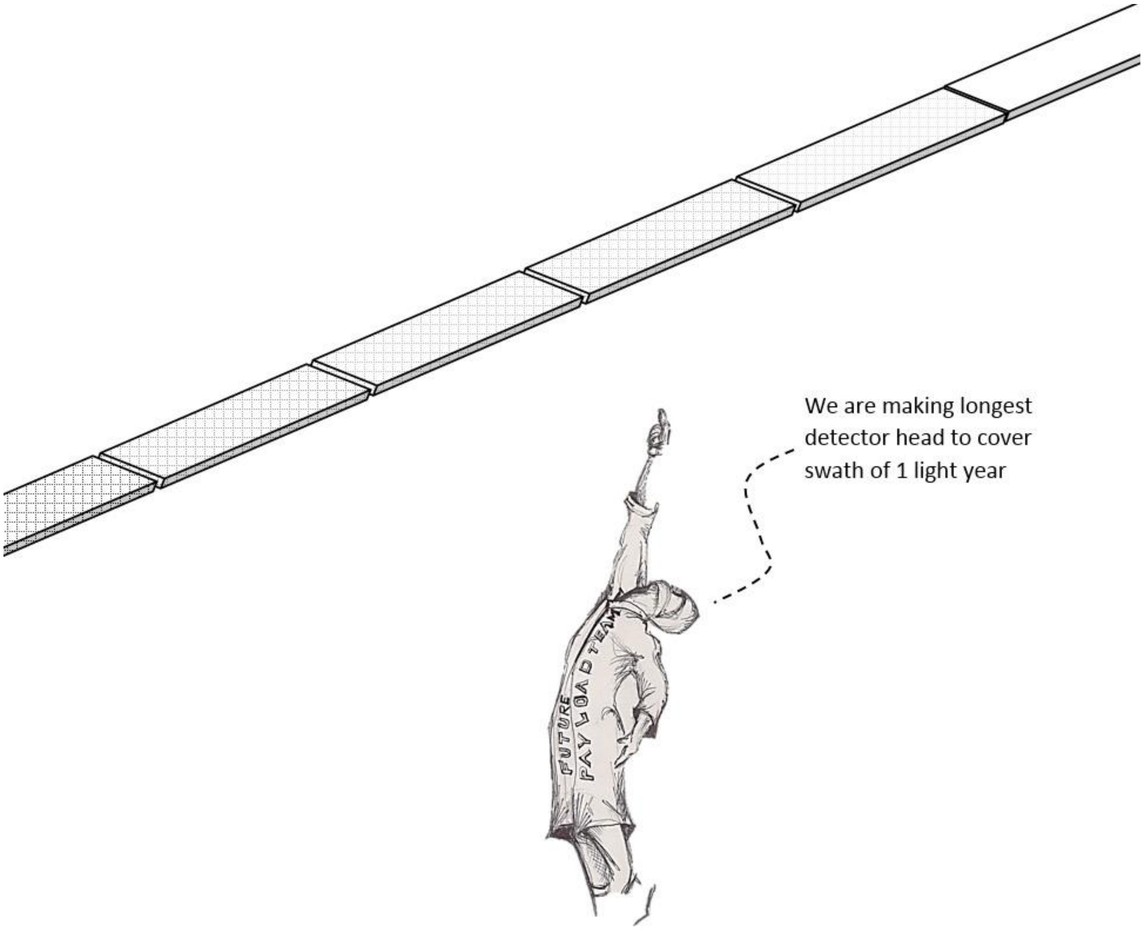


Figure 7: RISAT image over Antarctica

Conclusion: This article is intended to provide a synoptic overview of the various microwave sensors and the basic data processing activities in the field of microwave remote sensing, which have evolved during the last few decades, at SAC

Acknowledgements: I would like to thank all the senior and junior colleagues in ISRO, who have helped me in various scientific capacities during my work in the field of microwave signal and data processing at SAC.



Cartoon: courtesy of Abhijit Chatterjee

Satellite Navigation System based Meteorology

KaushikGopalan

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Introduction: Global Navigation Satellite Systems (GNSS), especially the Global Positioning System (GPS), has been used to derive water vapour information for over two decades [1]. Accurate measurements of water vapour are important for a whole range of meteorological applications ranging from detection and short-range forecasting of thunderstorms to assimilation in numerical weather prediction (NWP) models. GNSS signals have been used to measure atmospheric information through satellite based radio occultation instruments such as the ROSA (Radio Occultation Sounding of the Atmosphere) payload on the Indo-French Megha-Tropiques satellite, which has been discussed in previous issues of Signatures. This article will describe a different application of navigational signals, i.e. the estimation of atmospheric water vapour using surface-based navigational system receivers.

Globally, water vapour measurements are primarily obtained using satellite-borne infrared (IR) and microwave instruments and by twice-daily radiosonde launches over many sites. IR instruments on geostationary satellites have extensive spatial and temporal sampling but are inaccurate in cloudy regions. Microwave instruments are more accurate in cloudy regions than IR instruments, but they tend to have sparser temporal sampling due to their low-earth orbits. In addition, they tend to be less accurate over land than over the oceans. Radiosondes are highly accurate, but have sparse spatial and temporal sampling. Due to the various limitations in conventional water vapour measuring systems, satellite navigation based water vapour measurements can have significant utility in meteorological applications.

The use of navigational system based water vapour estimates has been extensively explored by meteorological agencies around the world. The US National Oceanic and Atmospheric Administration (NOAA) operates a GPS network that consists of more than 600 sites, primarily over North America. Similarly, the European EUMETNET GPS Water Vapour Programme (E-GVAP) consists of a network of more than 500 stations, the estimates from which are being assimilated operationally in NWP models. There have been many studies evaluating GNSS based Integrated Water Vapour (IWV) by comparing them to radiosondes or NWP model reanalysis datasets. These studies have generally reported accuracies of better than 6-8% compared to the reference data. For example, Troening et al. [2] compared GPS-derived IWV over Cape Grim, Tasmania to radiosonde and microwave radiometer (MWR) derived estimates, and found that GPS-derived values were accurate to ~1.5mm. A study by the UK Met Office [3] found that assimilation of GPS water vapour estimates resulted in improvement of up to 15% in skill in the forecasting of cloud-related variables.

In the Indian context, the Indian Meteorological Department (IMD) operates a handful of GPS stations around the country [4]. Further, the Indian Regional Navigational Satellite System (IRNSS) being developed by ISRO will consist of a constellation of seven satellites, all of which are likely to be continuously visible to Indian stations. In addition to its core navigational functions, the IRNSS (in conjunction with existing GNSS systems) has the potential to further reduce the errors in water vapour estimates throughout the Indian region.

Measuring water vapour from navigational signals:

The IWV in the atmosphere is estimated from satellite navigation signals as a function of the propagation delay introduced in the signal. The first step in this estimation is to separate the delay introduced in the troposphere from the delay introduced by the ionosphere. This is achieved by taking advantage of the fact that the ionospheric delay is highly frequency dependent whereas the tropospheric delay is not. Thus, using dual-frequency receivers (L1/L2 bands for GPS), the ionospheric delay can be determined based on the difference in the delays observed at the two frequencies. The ionospheric delay is subtracted from the total, and the remainder is the tropospheric delay.

The tropospheric delays from all available satellites in view are averaged after scaling each value based on the elevation angle of the satellite, such that the averaged value is equivalent to the delay that would have been observed if the signal had originated directly overhead. This averaged propagation delay is called the Zenith Tropospheric Delay (ZTD). The ZTD is further modelled as a combination of a zenith hydrostatic delay (ZHD) (which does not depend on atmospheric humidity) and a zenith "wet delay" (ZWD) which is a function of the IWV.

The ZHD (in millimetres) can be modelled as a function of the surface pressure at the station. The Zenith Wet Delay is then obtained by subtracting the ZHD from the total tropospheric delay. Finally, the IWV (in millimetres) is expressed as a function of the ZWD andthe pressure-weighted mean temperature of the atmospheric column (Tm). Bevis [1] expresses Tm as a linear function of the surface temperature.

Thus, the integrated water vapour content in the atmosphere can be measured accurately using (i) measurements from GNSS receivers on the ground as well as (ii) estimates of surface temperature and pressure.

Summary:

The use of Satellite Navigation signals to estimate meteorological parametersis a promising and fast-developing area of research. In particular, the use of the propagation delay in satellite navigation signals to estimate atmospheric water vapour is well-established and is being used widely all over the world. In the Indian context, the IRNSS has the potential to further reduce the errors in water vapour estimates throughout the Indian region and could potentially have a positive impact on applications such as short-term forecasting of rain systems and also be useful upon assimilation into numerical weather prediction models.

Acknowledgements:

The author thanks Dr. Raj Kumar,Dr. V. Sathiyamoorthyand C. Mahesh for their extremely helpful comments.

References:

[1] M. Bevis, S. Businger, T. A. Herring, C. Rocken, R. A. Anthes, and R. H. Ware, "GPS meteorology–Remote-sensing of atmospheric water-vapor using the Global Positioning System", J. Geophys. Res., 1992.

[2] P. Tregoning, R. Boers, D. O'Brien, and M. Hendy, "Accuracy of absolute precipitable water vapor estimates from GPS observations", J. Geophys. Res., 103, 28,701–28,710, 1998.

[3] Gemma V. Bennitt and Adrian Jupp, "Operational Assimilation of GPS Zenith Total Delay Observations into the Met Office Numerical Weather Prediction Models", Monthly Weather Review, 2012

[4] IMD GPS data, http://www.imd.gov.in/section/satmet/dynamic/gps.pdf

Astronauts' hearts become more spherical in space

New findings from a study of 12 astronauts show the heart becomes more spherical when exposed to long periods of microgravity in space, a change that could lead to cardiac problems, according to research to be presented at the American College of Cardiology's 63rd Annual Scientific Session

SIN(X)/(X) Correction for Flattening DAC Frequency Response

Abhishek Kunal, ShaliniGangele and Nilesh M Desai

Introduction

A real world DAC output is a "Zero order hold"; meaning that it holds the voltage constant for an update period of 1/Fs, where Fs is the sampling frequency. In frequency domain, this zero order hold introduces sin(x)/(x) distortion (also called aperture distortion). As shown in Fig. 1, the amplitude of output signal spectrum is multiplied by |sin(x)/x| i.e. the sinc envelope, where x=π*f/Fs.

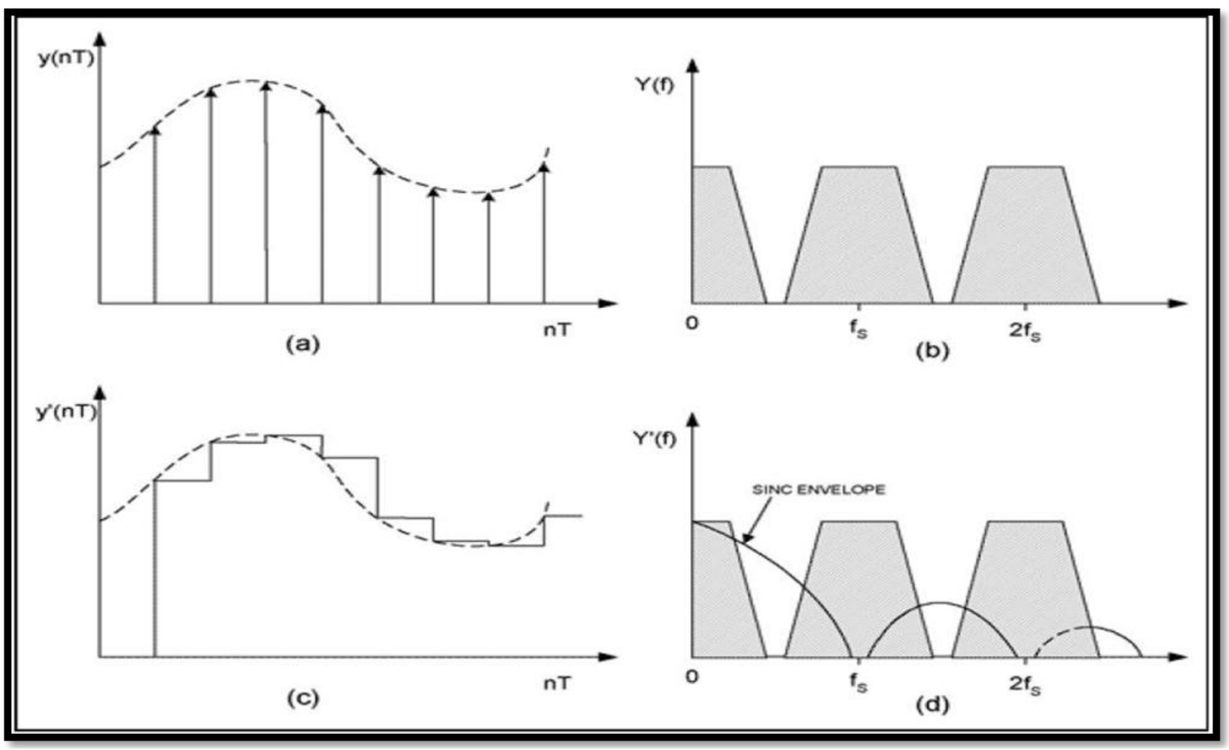


Figure 1: Frequency response of a real world DAC

As seen from Fig. 1, the desired signal frequency in the first Nyquist zone is reflected as a mirror image into the second Nyquist zone between Fs/2 to Fs, but the amplitude is attenuated by a sinc function. Image signals also appear in higher Nyquist zones, which can be removed using suitable reconstruction filters.

At 80% of the Fs/2, the frequency response is attenuated by 2.42dB and at Fs/2 this attenuation increases to 3.92dB. This loss is unacceptable to certain applications which require flat frequency response. There are several techniques that can be used for coping with the non-flat frequency response. Some of these are to increase the sampling frequency, employ post equalization technique or pre equalization methods. Post equalization technique employs analog filters consisting of active components whose design and fine tuning is rather difficult. Increasing the sampling frequency of the DAC adds to complexity and cost and does not completely eliminate the effect of roll off. So, the third option i.e. Pre equalization technique which makes use of signal processing to flatten the DAC response has been taken up.

Pre-equalization technique

Fig.2 shows the overall scheme used to cancel the effect of sinc roll off in a DAC. The pre equalization filter(inverse filter) first filters the input data to equalize the baseband signal and then sends the signal to the DAC followed by a reconstruction filter.

Fig 3.shows the time domain I and Q signals, its FFT spectrum and envelope for both compensated as well as uncompensated DAC. All the graphs in red color are for compensated DAC. As seen from the figure, the chirp signal envelope and spectrum is almost flat. The droop has now reduced to less than 0.5dB. One another observation is that the amplitude level of the compensated DAC is slightly lesser than the actual signal. This can be compensated by either choosing appropriate scaling factor or using suitable gain improving circuitry. The order of the filter and the resolution of quantized coefficients to be stored in the look up table can be traded off depending on the resource availability in the hardware.

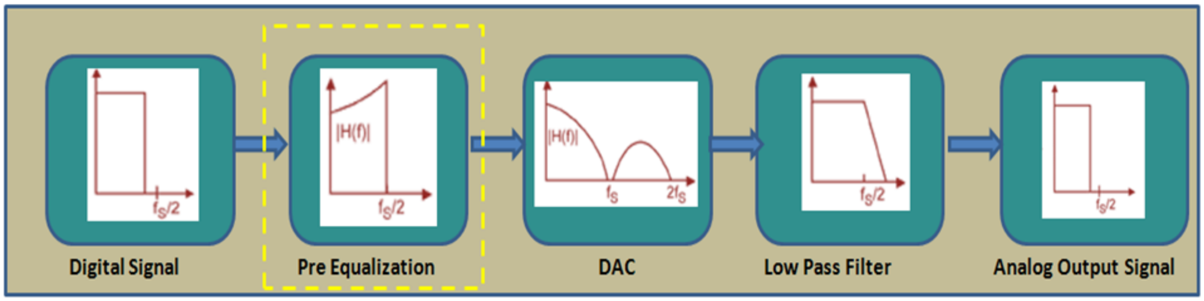


Figure 2: Pre Equalization technique

Sampling Frequency	=	125 MHz
Order	=	64
Pass Band Frequency	=	38MHz
Damping Factor	=	0.70
Inverse Sinc Power	=	1.0
Stop Band Attenuation	=	-100 dB
Ripple	=	0.01dB peak to peak

Table 1: Specifications of Inverse Sinc Filter

An inversesinc FIR(Finite Impulse Response) filter of the following specifications were generated and stored in a look up table in the hardware .

A chirp signal of Bandwidth 75MHz, Sampling Frequency 125MHz and Pulse Width of 50µSec was generated in the hardware and the inverse sinc filter was applied to the generated chirp before feeding it to the DAC.

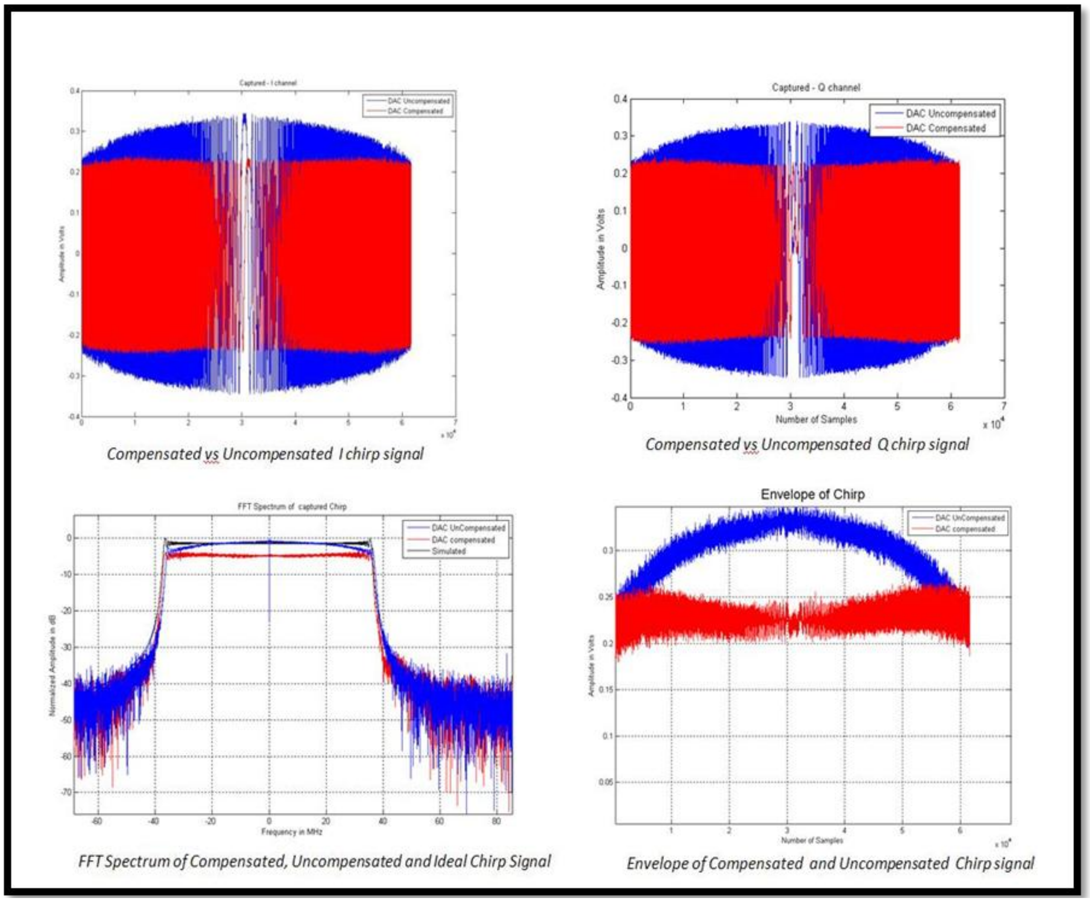
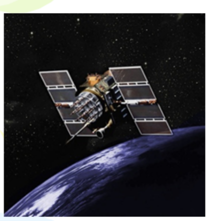


Figure 3: Compensated DAC vs. Uncompensated DAC response

Robotic Refuelling Of Spacecraft to Be a Reality Soon



The robotic refuelling technologies would equip robots and humans with the tools and capabilities needed for spacecraft maintenance and repair, the assembly of large space telescopes and extended human exploration, NASA said. (Photo : GPS.gov gallery)

3D Printing Technology - An overview

Ulkesh B. Desai

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Introduction:

3D printing or Additive manufacturing (AM) is a process of making a three-dimensional solid object of virtually any shape from a digital model. 3D printing is achieved using an additive process, where successive layers of material are laid down in different shapes. 3D printing is also considered distinct from traditional machining techniques, which mostly rely on the removal of material by methods such as cutting or drilling (subtractive processes). A 3D printer is a limited type of industrial robot that is capable of carrying out an additive process under computer control.

The first published account of a printed solid model was made by Hideo Kodama of Nagoya Municipal Industrial Research Institute in 1982. The first working 3D printer was created in 1984 by Charles W. Hull of 3D Systems Corp. Hull published a number of patents on the concept of 3D printing, many of which are used in today's additive manufacturing processes. Of course, 3D printing in the early days was very expensive and not feasible for the general market. As we moved into the 21st century, however, costs drastically dropped, allowing 3D printers to find their way to a more affordable market.

The 3D printing technology is used for both prototyping and distributed manufacturing with applications in architecture, construction (AEC), industrial design, automotive, Aerospace, military, engineering, dental and medical industries, biotech (human tissue replacement), fashion, footwear, jewelry, eyewear, education, geographic information systems, food, and many other fields. A sector vise distribution of the application of additive manufacturing is presented in figure1. As the technology advances, more and more practical uses are expected to come about as a result of additive manufacturing. With the addition of 3D digitizers, 3D sensors and 3D scanners, the possibilities are almost endless.

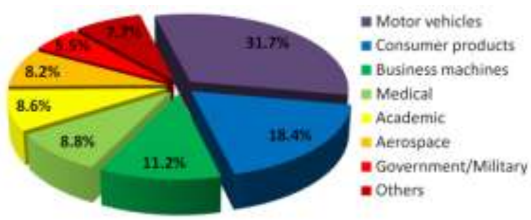


Figure 1: Sectoral distribution of application of additive manufacturing

3D printable models may be created with a computer aided design package or via 3D scanner. The manual modeling process of preparing geometric data for 3D computer graphics is similar to plastic arts such as sculpting. 3D scanning is a process of analyzing and collecting data of real object; its shape and appearance and builds digital, three dimensional models.

Additive Processes:

A large number of additive processes are now available. They differ in the way layers are deposited to create parts and in the materials that can be used. Some methods melt or soften material to produce the layers, e.g. selective laser melting (SLM) or direct metal laser sintering (DMLS), selective laser sintering (SLS), fused deposition modeling (FDM), while others cure liquid materials using different sophisticated technologies, e.g. stereo lithography (SLA). With laminated object manufacturing (LOM), thin layers are cut to shape and joined together (e.g. paper, polymer, metal). Each method has its own advantages and drawbacks. The main considerations in choosing a machine are generally speed, accuracy, cost of the 3D printer, cost of the printed prototype, and cost and choice of materials and color capabilities.

Some Applications of 3D printing technology:

Aerospace: The 3D printer developed by Made in Space is expected to be delivered to the ISS for the "3D Printing in Zero-G Experiment" by SpaceX's robotic refurbishing mission in Fall 2014. The machine, which is capable of printing about 30% of the tools needed aboard the ISS, will be used to provide scientific foundations for future additive manufacturing away from Earth and demonstrate the long-term effects of micro-gravity on 3D printing. It will also lay the foundation for a full Additive Manufacturing Facility (AMF) to be flown into orbit at a later date, to enable multiple space based 3D prints. NASA has also funded a research team for working on 3D printable pizza in space for its longer missions to the red planet. Since 2009, NASA's Desert Research and Technology Studies (D-RATS) have been developing a new SUV-sized manned rover, which, keeping with their reputation as a technology innovator, is made with 70 parts that were fabricated using a Stratsys' Fortus FDM 3D printer.

Figure 2: Future MARS rovers run on about 70 AM parts

At Space Applications Centre we are in the process of realizing some of our complex microwave components used in communication and remote sensing payloads. These components have a complex geometry and cannot be realised without splitting open the cavity and then assembling the split parts by means of fastening. Joining the split components often introduce problems such as misalignment of upper and lower half, improper electrical contact and RF leakage. By use of additive manufacturing techniques such problems can be avoided and the components realised in a single piece. The processes being explored are Selective laser sintering and micro laser sintering.

Automotive: As early adopters of rapid prototyping, the automotive industry undoubtedly has more 3D Printing applications than most other sectors. Because in each step of the development process, it is the ideal tool to verify or communicate the design. From concept car to detailed engineering, it matches the prototype as close to reality as possible. Components such as front fenders, scale model of entire car, door frames, seating design, equipment panels, assembly jigs and fixtures etc are realised by AM. Now, all leading Motor sports teams are using AM for direct digital manufacturing (DDM) of production parts. In doing so, teams have demonstrated that additively manufactured parts have the quality and durability to meet the demands of racecars of all types. 16 student engineers from a Belgium based Group T hit the headlines with "Areion" – World's first formula car made almost entirely of 3D printed parts. The 'Areion' was designed and built for the Formula Student 2012 challenge and tested on the Hockenheim race circuit in Germany, where Formula 1 Grand Prix's are also held. Areion took approximately four seconds to accelerate from 0 to 100 km/h, and finally reached 141 km/h top speed.

Figure 3: Areion- taking part in a racing event

Medical: The Medical industry is one of the three fastest growing sectors for additive manufacturing alongside automotive and aerospace. The marriage between additive manufacturing and the medical industry has been a happy one, leading to new applications all the time. The technology's success in the medical sector rests with its ability to create orthotics, prosthetic and personalised implants. Designers and engineers can produce organic, custom shapes in an increasing number of materials that are biocompatible, such as Ti6A14V, or even capable of being sterilized, such as ABS-M30i. For example, trabecular structures, which are fine, lattice-shaped

Figure 4: Acetabular cup with SEM showing the trabecular structures

structures that allow living bone to fuse to an implant, a process called oseointegration. Arcam AB (Mölndal, Sweden), which specializes in electron beam melting (EBM) additive manufacturing, now allows the ability to specify pore geometry, pore size, and density and roughness of structures for trabecular structures and surfaces. With a fast-growing list of additive manufacturing materials that are certified for medical use, additive manufacturing is expected to continue its fast growth in the medical field. From fractured sculls/joints, tissue growth etc to customized Exo-skeletons for physically challenged patients, additive manufacturing has helped doctors realise simple solutions to complex problems.

Applications of this technology have just begun and there are no limits to what it can achieve.

Factories of Future:

Additive manufacturing is green technology at its best. Aiming towards zero waste production, a kilogram of raw material would go into making a kilogram of end product, which translated into enormous cost savings and energy efficiency. Industry Experts foresee numerous applications of this technology in the future as it provides design flexibility, shorter design cycles, less material scrap, increased product complexity etc. Limitation of AM technology currently is the size of an object being realised, accuracy of geometrical features and a limited array of material options be it metal or a polymer. Research thrust area is towards generating high quality end products with good repeatability and efficient supply chain providing quality raw material and design of 3D printers with multiple print heads for faster realisation of large size components.

A day may come when one can 3D print a customised coffee mug at home, fix a broken component of their vehicle, make oneself a dental implant, make a custom jewellery, wear a laser sintered dress designed as per the latest trend for the season, print one's lunch and so on. The factories of future have shrunk into your home.

Can we have Lunar base with 3D printing?

Setting up a lunar base could be made much simpler by using a 3D printer to build it from local materials. Industrial partners including renowned architects Foster + Partners have joined with ESA to test the feasibility of 3D printing using lunar soil.

Source of Information:

www.3dprintingindustry.com; www.stratasys.com; www.Wikipedia.com; www.forbes.com; www.nasa.gov.in; www.esa.int

ISRS-AC ACTIVITIES

1. FELICITATING SHRI A S KIRAN KUMAR FOR PADMASHRI AWARD (FEBRUARY 20,2014)

Padma Awards - one of the highest civilian Awards of the country are given in various disciplines. Shri Kiran Kumar Alur Seelin, Director, Space Applications Centre, ISRO, from Gujarat has been awarded the Padmashri for distinguished service in the field of Science and Engineering. It was a moment of glory and extreme joy for ISRS-AC to felicitate Shri A S Kiran Kumar for the Padmashri award. While humbly accepting the love and affection of the professionals, Shri Kiran Kumar highlighted the increased expectations and responsibility that such recognition brings to the scientific community. A large number of professionals attended the function to felicitate Shri Kiran Kumar.

Figure 1: Felicitation function of Shri A S Kiran Kumar

2. 15TH PROF P R PISHAROTY MEMORIAL LECTURE (FEBRUARY 20,2014)

Shri A S Kiran Kumar, Director, Space Applications Centre, ISRO, Ahmedabad, delivered the 15th Prof. P R Pisharoty lecture on "Evolution of ISROs Earth Observation Programme“. Shri Kiran Kumar took the audience to the journey of ISRS’s EO Programme wherein he highlighted the challenges faced and the courage and innovations with which the Indian scientists could overcome the same. He shared the vision for the future EO Programme The lecture was well received with the participation of more than 500 professionals.

Figure 2: 15TH PROF P R PISHAROTY MEMORIAL LECTURE

3. WORKSHOP ON 'IRS-25 YEARS: GEOSPATIAL TECHNOLOGIES-PAST, PRESENT AND FUTURE' (MARCH 22, 2014)

A half day workshop 'IRS-25 years: Geospatial Technologies-Past, Present and Future' was organised on March 22, 2014 at Nirma university jointly with Civil Engineering Department of Nirma University. Dr George Joseph, Honorary Distinguished Professor, ISRO and former Director, Space Applications Centre, ISRO, Ahmedabad, inaugurated the Workshop and enlightened the participants with a talk on the evolution of remote sensing in India. He captivated the audience with his memoir right from some of early

Figure 3: WORKSHOP ON 'IRS-25 YEARS at Nirma University, Ahmedabad

remote sensing experiments to the latest development in the country in the Remote sensing field. Shri D R M Samudraiah, Prof Satish Dhawan Scientist and Former Deputy Director, Sensor Development Area, Space Applications Centre, ISRO, Ahmedabad delivered talk on 'Engineering challenges in Design and Development of Indian Electro-Optical Remote Sensing sensors' and Shri Tapan Misra, Deputy Director, Microwave Remote Sensors Area, Space Applications Centre, ISRO, Ahmedabad delivered popular talk on 'India's Microwave Remote Sensing Programme: Past-Present and Future'. Participants could capture the complete gamut of Past Present and Future of the Indian remote sensing programme. Around 50 students participated in the workshop. Students presented Poster on the theme, "All about Remote Sensing through Satellites and its applications" wherein they covered different aspects of Geospatial technology like: Innovations in Satellite architecture, Materials used for the making Satellites, Satellite Sensors, Type of data collected, and Application of Satellite Data. Five prizes to the poster presented by the students were given by ISRS-AC. The workshop ended with the prize distribution ceremony.

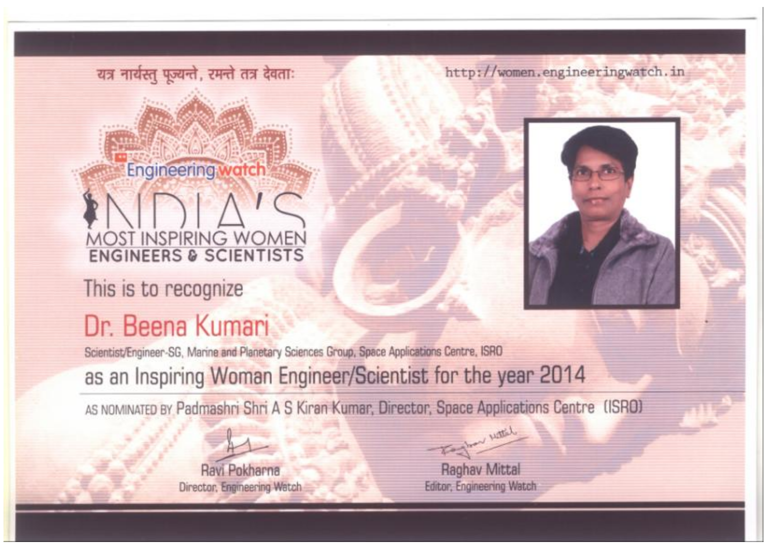
4. EDUCATIONAL EXCURSION (OCTOBER, 19-20, 2013)

The Indian National Cartographic Association-Gujarat Branch (INCA-GB), Indian Society of Remote Sensing - Ahmedabad Chapter (ISRS-AC), The Indian Society of Geomatics - Ahmedabad Chapter (ISG-AC), and Indian Meteorological Society - Ahmedabad Chapter (IMSA) jointly conducted an environmental educational excursion to Bhuj--Mandavi--Mata-no-Madh--Koteshwar during 19 - 20 October, 2013. The participants visited some of Geologically Important places like MARS Analogues site at Mata-no-Madh along with some of historical places in and around Bhuj, Mandavi, Koteshwar. Dr R P Singh explained the importance of Mars Analogues to the participants. There were 82 participants including members and their families. The enthusiasm of the participants after announcement of the event and during the tour is worth mentioning. All the participants enjoyed the entire tour and hospitality provided by the organisers.

Figure 4: Educational Excursion

AWARDS

Shri AS Kiran Kumar, Director, SAC was awarded the "PADMASHRI" in 2014



Dr. Beena Kumari received Inspiring Woman Engineer/ Scientist Award for the year 2014

SUPERANNUATION (October 2013- March 2014)

Dr Ajai

Shri RK Goel

Dr N. Padmanabhan

Shri S.P. Kachhela

Congratulations and welcome to ISRS-AC Executive Council 2014-2016

ISRS-AC Executive Council 2014-2016 was elected unopposed during 30th AGM held on March 22, 2014

Chairman	:	Shri Tapan Misra
Vice-Chairman	:	Shri V K Jain
Secretary	:	Shri H K Dave
Joint Secretary	:	Shri Anurag Kandya
Treasurer	:	Shri Amit Shukla

Members :

1. Shri Jamin T Desai
2. Dr Arun Bhardwaj
3. Shri Kartik Bhalsod
4. Shri Ritesh Kumar Sharma
5. Shri Harish Sheth

From Secretary's Desk

Dear Members,

I wish to express my sincere regards to all the members of ISRS-AC for making my tenure memorable as a member of executive council of ISRS-AC for the term of 2008-2010 and as Secretary, ISRS-AC for two terms 2010-2012 and 2012-2014. I have been fortunate to get guidance and support from Padmashri A S Kiran Kumar, Shri D R M Samudraiah and Shri D Subrahmanyam during the three terms. I express my sincere regards for their guidance, encouragement and support due to which ISRS-AC could contribute for the cause of advancement, dissemination and application of the knowledge of remote sensing technology. Due to whole hearted support and active enthusiastic participation from the ISRS-AC EC team members, a number of activities could be organised to pursue the goal of ISRS. In addition to organising celebrations of World environment day, National Remote Sensing day, the prestigious Prof P R Pisharoty memorial and L N Calla memorial lecture series, organising few popular lectures and organisation of five free of charge workshops on topics like Chandrayaan, RISAT-1, 25 years of IRS, joint workshops on Geoinformatics for Urban Planning and 10 years of Kalpana-1 was satisfying. These workshops were not only beneficial to the members, but it also involved college students and other professionals. Thus, while they provided platform for interactions amongst professionals from different fields, for students it was an opportunity to understand the advancements in the field of space applications.

Editors of Signatures, Dr Nandakumar and his team during 2010-2012 and Smt Arundhati Misra and her team during 2012-2014, have put immense efforts in bringing out twelve issues including eleven thematic issues in the last two terms. The Editors along with guest editors for three thematic issues Dr Prakash Chauhan, Dr R P Singh, Dr Ramakrishna, have contributed in bridging the gap between the members and the experts in specific themes. The contribution from theme experts in form of very informative articles has been backbone of the quality that Signatures has achieved. Signatures has covered eleven themes namely, Applications of DEM in RS&GIS, Non-Imaging sensors RS, Microwave RS, Industry contribution to RS, Atmosphere and Oceanic RS, Astronomy and Planetary RS, Future trends in RS, RISAT-1, Meghatropiques, IRS-1A Reminiscences Climate Change and RS, RS data products and Retrievals. The current issue is containing general articles of interest. I have received feedback from a number of members regarding the enthusiasm that these issues have created amongst fellow professionals. I wish to express my sincere gratitude to the editorial teams and the authors for making Signatures a landmark.

I wish to express my sincere gratitude to Dr R R Navalgund, Dr J S Parihar, Shri N S Mehta, Shri R P Dubey, Shri K P Bharucha, and all the senior members for their continued support throughout. During the past four years increased joint activities could be taken up due to active cooperation amongst ISRS-AC, ISG-AC, IMS-AC, INCA and SSME resulting in very useful interaction between professionals from different fields. What has been heartening is the increase in active participation of the members in various activities. The interest and enthusiasm that the members have shown in the society's activities is commendable.

I thank one and all for giving me this opportunity to contribute for the cause of the society. I once again thank all the members for their active contribution, enthusiasm and extending all the support which made my tenure truly satisfying and memorable for me. I would like to extend my heartiest congratulations and best wishes to the new team of executive council of ISRS-AC for the term 2014-2016.

Best Regards,

Dr Parul Patel

From The Editor's Desk

" As we look ahead into the next century, leaders will be those who empower others"
~ Bill Gates

It's my great pleasure to announce that our editorial team has successfully brought out theme based issues during the past two years. The feedbacksfrom many of our readers have been quite encouraging, in this regard, and we have tried our best, to keep the themes as interesting and as informative as possible.

It has been a great team work. With all the work pressures of various critical projects, which are obviously our priorities, it was a tremendous experience for all of us, whereby all the members tried to balance the Signatures' activities and all other official responsibilities with our prime aim of 'bringing out the best possible' Newsletter and strive for 'still better'! I wonder if we have been able to satisfy our esteemed readers or not. It would be very nice if we could get some feedback in this regard. Of course we expect that all our readers have an 'insatiable hunger' for quality scientific articles in this Newsletter - "Signatures".

Now that we have completed the stipulated two years term, we would be happy to hand over the responsibilities of the 'Editorial 'of Signatures to a more deserving team.

Before we wind up this issue, I would like to extend my heartiest congratulations to the editorial team for their enthusiasm and efforts. On their behalf I would also like to say that we are extremely thankful to Sri D Subrahmanyam, Chairman ISRS-AC, Sri D R M Samudraiah, Vice-President, ISRS, and DrParul Patel, Secretary, ISRS-AC for their constant help and guidance in bringing out all the issues of Signatures.

This issue of 'Signatures' is a general 'Newsletter'. Here only a few scientific articles have been kept, which were contributed by some of our enthusiastic readers and members. Brain storming amongst our young team members brought out the idea of incorporating some fun aspect to the magazine, whereby a few brain teasers/quiz and cartoons have been put up. Hope our readers find this new aspect entertaining, for a change.

I am extremely thankful to the ISRS-AC team for entrusting us with this responsibility of Editorial work, and giving us full liberty to work in an independent manner.

Best wishes to all our readers and happy reading.

Arundhati Misra(Ray)

Editor, ISRS_AC

Signatures

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ISRS-Ahmedabad Chapter

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