



SPACE

SCIENCE. TECHNOLOGY. APPLICATION.



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WELL-DONE SCIENTISTS!

SPACE Newsletter congratulates all ISRO and DRDO scientists for their recent immense achievements.

India now possesses the capability to strike targets in outer space with high precision. This test by DRDO on March 27 catapulted India as a space military power alongside the US, China and Russia

The PSLV-C45 lifted off at 09:27 Hrs (IST) on April 01, 2019 from the second launch pad of Satish Dhawan Space Centre SHAR, Sriharikota in its 47th flight. This flight marked the first mission of PSLV-QL, a new variant of PSLV with four strap-on motors. India's PSLV-C45 successfully injected EMISAT for DRDO and 28 international customer satellites into their designated orbits.

NEW SPACE TECHNOLOGIES

For curious researchers, here it goes, some innovative new space technologies to enhance our future space based services capabilities

- 1) Small satellites like NASA's twin communication interplanetary cube-sats with short development time frame are becoming efficient platforms for scientific research
- 2) Machine Learning (ML) is poised to revolutionize Satellite Operations in any orbit (ie GEO, MEO and LEO).

With high computational processors, dedicated AI chips for space applications, Machine learning integrated with on-board software provides an objective set of tools for automating satellite operations enhancing current capability, facilitate more complex operations at reduced operational costs.

- 3) Software defined satellites. It is the age of software defined Radios, software defined networks, software defined components and so on. Carrying these ideas further, we should think of software defined satellites which will enable designing platforms for multiple applications
- 4) Cost effective satellite Network ground infrastructure with state of the art connectivity, range of bandwidths, wireless services is possible today. Thanks to advances in miniaturized antenna hardware design and manufacture through metal 3 D printing as part of 4th Industrial revolution. High performance antennas with mass customization, low volumetric size, etc provide much needed competitiveness.
- 5) 5G satellite systems. The roll out of 5G mobile services with unlimited capacity and 1-10 Gbps speed at our door step. To get full benefit of 5G at much reduced cost there is necessity to manage a hybrid mix of microwave, fibre and satellite.
- 6) Creating space based cloud and enterprise network services. To overcome rampant cyber security threats and data breach on terrestrial based cloud system, it is proposed to have space based cloud system using any orbital satellite system with much better cybersecurity coverage.



JRD Tata

DIGITAL TWIN FOR FIXING SATELLITES IN SPACE

We design satellites with a high degree of reliability and some limited redundancy in order to operate properly. Common problems like sensor failure leading to incorrect control command or an actuator failure resulting in improper application of controller's command to the satellite. To overcome this, we have health monitoring systems capable of detecting a fault as it occurs and identifying the faulty component. Digital Twin concept makes this fixing much more efficient and practical.

Digital Twin is an exact replica of a product with all its operational features generated using that product's real time information collected via several smart sensors. IOT, AI, Data Analytics, increased data storage capabilities, simulation and visualization techniques etc are making this unique innovation possible. Engineers can leverage this animated visual representation of a physical system for performance monitoring and process optimization. Dr Michael Grieves from University of Michigan was the first to put forth this model in 2002. So to say, today, we can make a digital 3D copy of an inflight aero gas Turbine, a physical twin, based on physical data of the turbine (3D model, performance data, environment data, external conditions etc.) and visually see on the computer on the ground how it is working real time. This technology is adoptable to any scale, and highly flexible without dimensional constraint. Any malfunction in the operational turbine can be easily identified and corrected in real time in this large data driven process using suitable neural networks. Extending this new Digital twin concept, one can test, design, and improve a new product in a virtual environment before its launch at much less product development cost. In addition, maintenance professionals will have a better understanding of the product life cycle and can even prepare better maintenance schedules as part of their predictive maintenance strategy for extending equipment life and reducing down time. NASA has started using Digital twin in their space craft design. US air force first time used in the analysis of F-15 airframe and other equipment, GE, the manufacturer of jet engines, Siemens, another industrial giant are offering expertise in this field. IBM is marketing digital twins as part of its IoT technology, and Microsoft is offering its own digital-twin platform. ANSYS Twin Builder 19.1 software, our researchers can now build, validate and deploy simulation-based digital twins within a single workflow.

UNNATI (UNISPACE NANOSATELLITE ASSEMBLY & TRAINING BY ISRO)

During the "54th session of Scientific & Technical Sub Committee of COPUOS (United Nations Committee on the Peaceful Uses of Outer Space)" at Vienna in February 2017, UNOOSA (United Nations Office for Outer Space Affairs) requested member states to propose new initiatives for UNISPACE. India suggested for conducting a capacity building UNNATI (UNISpace Nanosatellite Assembly & Training by ISRO) programme on small satellites realisation through a combination of theoretical coursework and hands on training on Assembly, Integration and Testing (AIT). UNOOSA welcomed this concept and proposed to work jointly with India to make this programme a deliverable for UNISPACE+50 conference.

India announced about UNNATI programme in June 2018 as part of the 50th anniversary celebrations of the first United Nations conference UNISPACE+50. U R Rao Satellite Centre (URSC) being the lead centre of ISRO for satellite building has designed the basic structure of this programme with equal emphasis on theoretical and practical exposure. The primary objective of the programme is to provide theoretical course on Satellite technology, comprehensive course on Nanosatellite realization and hands-on training to assemble, integrate and test a low cost, modular Nanosatellite. The programme is scheduled to be conducted in three batches. The first batch of the above programme was scheduled during 15th January – 15th March 2019. 30 participants from 17 different countries have participated in this programme. Two more batches are planned during October 2019 & October 2020.

PROGRAMME ANNOUNCEMENT

	Batch 2	Batch 3
Commencement of registration	May 15, 2019	May 15, 2020
Last date to apply	June 30, 2019	June 30, 2020
Finalisation of candidates	July 31, 2019	July 31, 2020
Commencement of course	October 15, 2019	October 15, 2020
Completion of course	December 15, 2019	December 15, 2020

FEDERATED LEARNING: OPENING A NEW CHAPTER IN SPACE IMAGERY ANALYSIS

Images are major data from satellites. Challenge is how to identify and extract useful and accurate /discriminate information from these sat images. Everybody these days talk of Deep Learning as a tool to train our computers to efficiently recognise / discriminate objects or imagery of objects such as buildings, roads, vehicles, etc.in sat imagery. While deep learning is traditionally a centralised approach to train AI models,, Federated learning on the other hand is a new break through concept in AI with decentralised approach developed over last 2-3 years mainly by Google Research team. Putting it in a lighter way, in a Federal government system , the governance is federated. In the context of Federated Learning, knowledge is federated. It is complex to implement but in concept it is as simple as this. The added advantage of Federated Learning is to distribute the quality of knowledge say a sat image across a large number of devices with in built image recognition algorithm (decentralization). This approach improves the quality of otherwise centralised models while maintaining privacy of data sets. Each device will run an optimization algorithm such as stochastic Gradient descent (SGD) on this data and upload the results to the main servers for federated aggregation and construction of improved global model with additional advantage of protecting data privacy. FL techniques is currently used in a big way in all company services provided such as mobile vision API, Gboard app, Tensor Flow etc. In Gboard app Federated Learning allows mobile phones to work collaboratively to understand a shared prediction model with all training data secured on device, but without the necessity to store the data in the cloud. This goes beyond the use of local models that make predictions on mobile devices (eg: Mobile Vision API and On-Device Smart Reply) by making model training as part of the device capability.

USA: IT'S TIME FOR THE NEXT GIANT LEAP

With growing international competition in space exploration, NASA has been asked by Trump administration to accelerate its human space exploration program and put humans on the surface of the moon by 2024 instead

2028 by any means necessary. "We're in a space race today, just as we were in the 1960s." says US Vice President, Mike Pence showing urgency in the matter. The objectives are loud and clear:

To land a first US woman and the next, a US man in the lunar south pole launched by American rockets from American base in next 5 years. The moon's south pole is believed to hold enough ice which has great scientific, economic and strategic value.

PSLV C45 CARRIES ON 4TH STAGE (PS4) ISRO DEVELOPED AIS FOR MARITIME AWARENESS STUDIES BY ENTHUSIASTIC RESEARCHERS

The International Maritime Organization (IMO) has established a new International Convention (Dec 2004) for the Safety of Life at Sea (SOLAS) that requires Automatic Identification System (AIS) to be installed on all international voyaging ships with gross tonnage of 300 or more and on all passenger ships regardless of size.

AIS equipment transmits important information such as identification, position, course, and speed. With an AIS transponder equipped system, cruising ships can see positions of other vessels and calculate their own course to avoid collision. At present, the ground-based stations along the coast and the on board AIS transponders can only communicate with each other over a limited distance in horizontal direction. Now PS4 provides vertical communication with these transponders without any additional equipment from low earth orbit. Augmentation of Space-based infrastructure for AIS is an ongoing program. Researchers can use the PS4 platform data with suitable client software with functionalities suitable for their AIS needs, such as GUI interface to view operational ships traffic Now, the client software may query AIS data from the ground based data centres via several channels like Internet satellite relay or radio link. At present AIS has become a widely used tool for developing applications such as fisheries monitoring, marine conservation, maritime security, Anti- piracy, Underwater noise as well as pollution forecasting, ballast water monitoring, SOS etc.

This PS4 will remain in orbit for next six months for supporting experiments by enthusiastic researchers.

NEW ANTIMICROBIAL COATING KILLS MULTI-RESISTANT PATHOGENS ON THE ISS

ISS (International Space Station) which we all know is a closed, hostile and extreme habitat for astronauts whirling in the space orbits for days to months. The bacteria inside ISS become multi-resistant pathogens with growing up of thick cell wall and do not respond to normal known antibiotics or even detergents. Elisabeth Grohmann of Beuth University of Applied Sciences Berlin, who addressed this problem developed a new antimicrobial coating made of micro-galvanic silver and ruthenium which can be applied on all contamination-prone surfaces inside ISS to limit growth their colonies. "On Earth, these bacteria are generally harmless, but microgravity and cosmic radiation can increase their virulence and transform them into potential pathogens. These conditions also lower the immune defences of the astronauts, which, when coupled with the psychological stress associated with spaceflight, makes them much more prone to infection" says Elisabeth Grohmann. (REF: <https://physicsworld.com/a/antimicrobial-coating-kills-multi-resistant-pathogens-on-the-iss/>) 27 Mar 2019

ABOUT THIS NEWSLETTER

This quarterly News Letter from NIAS, IISc Campus is to bring out various latest and important S&T developments likely to find place in future space programs. The future programs include man in space, exploitation of extra-terrestrial resources, space based services, space exploration, science of microgravity, space for national security etc.,. The intention is to provide brief information to researchers, academicians, R&D personnel, Space industry to generate S&T leads in the minds of people. It is our endeavor to keep this newsletter fresh and engaging with well researched content. Any suggestion(s) for improvement of this newsletter will be highly appreciated.

- Editor

EDITOR'S PICK OF SPACE ARTICLES

This 37p recent article "A Comprehensive Assessment of Collision Likelihood in Geosynchronous Earth Orbit" is worth reading. Abstract of the same is reproduced below.

ABSTRACT: Knowing the likelihood of collision for satellites operating in Geosynchronous Earth Orbit (GEO) is of extreme importance and interest to the global community and the operators of GEO spacecraft. Yet for all of its importance, a comprehensive assessment of GEO collision likelihood is difficult to do and has never been done. In this paper, we employ six independent and diverse assessment methods to estimate GEO collision likelihood. Taken in aggregate, this comprehensive assessment offers new insights into GEO collision likelihood that are within a factor of 3.5 of each other. These results are then compared to four collision and seven encounter rate estimates previously published. Collectively, these new findings indicate that collision likelihood in GEO is as much as four orders of magnitude higher than previously published by other researchers. Results indicate that a collision is likely to occur every 4 years for one satellite out of the entire GEO active satellite population against a 1 cm RSO catalogue, and every 50 years against a 20 cm RSO catalogue. Further, previous assertions that collision relative velocities are low (i.e., < 1 km/s) in GEO are disproven, with some GEO relative velocities as high as 4 km/s identified. These new findings indicate that unless operators successfully mitigate this collision risk, the GEO orbital arc is and will remain at high risk of collision, with the potential for serious follow-on collision threats from post-collision debris when a substantial GEO collision occurs. [Copyright ©2017 by Analytical Graphics Inc. Authors: D.L. Itrogge*, S. Alfanob, C. Lawc, A. Cacioni and, T.S. Kelsoe & presented at 68th International Astronautical Congress (IAC), Australia, 25-29 September 2017]

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*We would appreciate your feedback and suggestions
on how to improve our newsletter*