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S P A C E Newsletter wishes all its readers 'Stay Healthy and Stay Safe'

SPACE TECHNOLOGY TO ASSIST IN GLOBAL HEALTH: SPREAD OF COVID-19

Today we have several Earth Observation Satellites launched by various agencies acquiring and sending huge environmental data like pollutants, population movement, transportation movement, construction on ground, weather conditions, climatic condition, oceanic conditions, chlorophyll etc. This kind of data is available since 1972 with the introduction of Landsat series satellites jointly by NASA and US Geological Survey. Now, the ongoing research is on how to integrate analytical technologies like ML, computational epidemiology, CFD etc blended with innovation with the uninterruptedly available satellite data to predict the outbreak of unknown diseases. This will help the policy makers to make informed decisions for the wellbeing of general public.

Did such thing happen in case of CoVID-19? Could we predict its arrival? Could we analyse its propagation? The answer is 'NO'. One should understand that no satellite imagery gives any direct information about a disease. Based on changes in various environmental factors that happen due to arrival and spread of a disease which are captured in the imagery, one can draw a fair conclusion about the existence of disease. Around 2000, satellite data was successfully used to predict outbreak of cholera, a bacterial infection caused by contaminated food and water through the analysis of satellite imagery of chlorophyll distribution among others.

Though lot of research has been done on the emergence of such SAR-CoV-1&2 viruses since 2003 and many researchers described this virus as ticking time bomb - meaning a big calamity is in the offing as early as 2007. Many articles have been written stating that this virus is entering from animals to humans due to culture of eating exotic mammals with least provision for required biosecurity systems in place especially in southern China. CoVID-19 is only a beginning. This is not going to be end since far more deadly viruses from wildlife is likely to enter human body if play a major role in the endeavor of at least avoiding such calamities in future.

In 2015 when Ebola disease broke satellite data was made use in disease management. University of Toronto and International Space University, France played a key role in this work. Similarly spread of malaria was well predicted in countries like Indonesia and Thailand by NASA through modelling and surveillance in collaboration with US Naval Medical unit. This helped the civic authorities with sufficient warning time to handle the endemic. The information was useful even to advise the farmers on how to use pesticides which will cause a reduction in drug resistant strains of disease carrying mosquitos. Space technology is so advanced it can be used to analyse and arrive at decisions like whether the outbreak was caused by bio terrorism or natural circumstances.

In a public release dated Nov 6,2007, the American Society of Tropical Medicine and Hygiene has stated that with the help of Earth Observation Satellites scientists have been able to observe the Environment to help predict and prevent outbreaks of infectious diseases anywhere in the world. Ability of infectious diseases to thrive and propagate depends on changes in Earth's environmental conditions.

Prof Rita R Colwell of University of Maryland developed a predictive model for CoVID-19 which is expected to become endemic and likely to revisit several times as virologists theorize. Her team has applied ML to huge corona virus data pouring from China, Italy, Spain and US to correlate with satellite data specific to each region. Though one could not predict the CoVID-19 due to lack prior knowledge when it occurred first time, now scientist like Prof Rita R Colwell believe its future occurrences can easily be predicted based on satellite data. According to Prof Timothy E Ford, Chair, Dept. of Environmental Health Science, University of Massachusetts Amherst it is not easy to predict out breaks of new viruses like CoVID-19 which is expected to transmit through wild meat or animal trading unlike pathogens transmitted through environmental routes or have environmental connection, based on satellite data.

JRD Tata

India having many data science expert teams working in the country should embark on a program utilizing satellite data to understand various aspects of corona virus which could cause irreparable damage to society, economy, industry, culture, natural resources etc. Repetitive outbreaks of this virus are not ruled out. Cure is still debated. Vaccines are non-available yet. Indeed, a big task on our hand to mitigate the effects of this virus!

SATELLITE DATA: POST CoVID-19 LOCKDOWN

Latest satellite data being monitored is showing decline in atmospheric pollution coinciding with lockdown throughout the world. This kind of reduction in pollutants like NO_2,CO_2,CO, and particulate matter- all indicate the effect of social, economic changes as well as changes in transportation network, commercial ports, oil refineries, heavy industry etc taking place in the world with the lockdown in the society. Though the satellite data could not help to predict the onset of the pandemic, however, satellite data can be used to understand, with the integration of modeling techniques like AI, ML, on how to mitigate the crisis situations in favor of economic sectors such as public health, industry, commerce, transport, shipping, agriculture etc. As a fall out of these changes it is observed that rivers are flowing with clean water, respiratory diseases other than CoVID-19 are under decline, less pollution of oceans is helping the fauna and flora in seawater, less pollution of air giving a breather to avian life and many more. All these phenomena can be seen from the satellite images. Such images from space will provide information to government agencies for planning better relief efforts to cope up with fast spread of disease. Pedestrian migration of daily wage earners from cities to villages in search of lively hood and employment can be monitored. Satellite data may show that we are not going places due to lock down, but it gives vital information on how to identify spots where aid is required, how to deliver aid, how to help people, how to advise on travel risks, industrial output, changes in oil reserves etc.

Data can be correlated with red zones of virus, check the degree of social distancing, and use this data as input to epidemiological models which tells how keeping people at distance improves the viral spread in that region.

Some efforts are required to use the satellite data effectively during pandemic. We cannot see buildings and roads on the maps, but one can see them clearly on satellite images. There are on-line tools which can be used to turn buildings and roads on top of maps taken from satellite images. There are companies like Maxar or Black sky or GRID 3 software which provide high resolution satellite snaps. It is not exaggerating to say a sheet of paper from printer can be spotted from an orbit. This helps to take snaps of areas which are restricted during pandemic and assess the situation and handling of patients / Public there.

In addition, Blacksky has a AI software which can indicate its satellites where to look and at what time -to get snaps one needed to get a grip of the situation in that location. If the data sum indicates something peculiar or a deviation from the normal, the software in the system sends a indicator message to the observer and also instructions to the satellite to concentrate at the interested spot for more pictures. These kind of features helps to utilize the satellite data more effectively during pandemics.

RUSSIA FIRES AN ASAT WEAPON! US SPACE FORCE DETECTS AND TRACKS!!

When the world is busy combating COVID-19, Russia fires advanced Anti Satellite Weapon(ASAT) missile capable of destroying a satellite in the Low Earth orbit on April 15,2020. In preparation, Soyuz rocket placed a satellite into LEO during last November which over a time split into two satellites Cosmos 2542 and 2543 and became targets for this test. It is reported that this is Russia's 10th test since 2014 and it is unclear whether it hit the target. This Russian missile system known as Nudol consists of a movable land vehicle carrying the ballistic missile with flexibility to launch from any location India, China and US are other countries who have successfully demonstrated this space technology. We cannot talk about the debris it created since it is unclear whether it hit the target or no orbital tracking system has tracked any debris.

CAN WE SERVICE AN ORBITING SATELLITE?

Until few days back, the technology was such there is no way to reach an orbiting satellite and repair the same in case it is non-functional. The satellite when turns non-operational simply remain in the space as junk. Till now, it was not possible to bring two fast zooming satellites in an orbit very close. Sometimes satellites run out of fuel and we are helpless in refilling the tank and then there is no way to use it other than decommissioning it. The speed is so high it is not easy to approach using another satellite to dock and do something. Day by day space is becoming unsustainable with all sorts of space debris.

But now, thanks to Northrop Grumman new technology, Intelsat 901 communication satellite is back in operation for another good 5 years after filling the required fuel by MEV-1 space craft and relocating to a new spot. The grappling device of MEV-1 worked perfectly at 22000 miles up above in what they call-grave yard orbit- to latch on and ferry to another spot.

This innovation of Northrop Grumman undoubtedly created history in space technology on April 02, 2020. Now Northrop Grumman is bracing ready to service Intelsat 1002 satellite running low on propellant (Ref the verge.com April 17). At least there is some solution

now to extend the life of satellites instead of retiring them early and adding them to space junk.

ERA OF ELECTRIC AVIATION HAS COME!

The world's first fully electric commercial flight took off on 10 Dec 2019 from Vancouver International Airport beginning a new era in aviation. The flight lasted 15 minutes covering 160 Km on Lithium ion battery. The Washington based company MagniX provided the 750 hp(560kW) the stand-alone electric motor for propulsion. The 62-year-old vintage six seater DHC-2de Havilland Beaver sea plane was used for this demonstration in partnership with well-known Harbor Air airlines of Canada signaling significant cost savings with zero emissions. MagniX company specializes in designing aviation motors with separately controlled and monitored 3 phase sections. The design is such if any fault is noticed during flight particular section can be shut down and remaining sections with 75% power can be used by the pilot with graceful degradation.

At a time when electric vehicles like automotive cars or electric trains have been easily realized, design of electric aviation vehicles have proved to be a big challenge. Of course, reasons are known. The current battery technology is such battery is heavy and expensive. In India we have to do a lot more to catch up with this disruptive innovation (www.dezeen.com) Another parallel electric aviation program is by NASA which is slated to launch in mid-2020 a X-57 Maxwell experimental aircraft with a range of 160 km and flight time one hour.

A twin engined Italian built 4 seater Tecnam P20006T is chosen for this demonstration with distributed electric propulsion wings. The propulsion package consists of 12 electric motors with propellers nacelles plus two bigger propellers at the wing tips as substitution to four-cylinder Rotax piston engine. NASA is trying to have smaller and lighter electric motors than equal powered jet engines.

SATELLITE FOR UNINTERRUPTED SECURE REAL TIME COMMUNICATION FOR US SEA, AIR AND LAND FORCES

President Donald Trump established the US Space US Space Force on Dec 20,2019 through NDA act. An extremely high frequency high data rate satellite AEHF -6 costing $1 billion was launched from Cape Canaveral Air Force station riding on ULA Atlas-5 rocket on March,26,2020 heralding the beginning of own satellite launches by the Space Force amidst CoVID-19 menace. This 13600 pound satellite is meant to provide US troops 24x7 reliable jam resistant real time data for both strategic and tactical global missions across sea, air and land theatres of war. With the launch of this satellite, one could say US plan of defence protection satellite program for war fighters is complete.

This shows how US is determined to maintain space superiority come what may.

INTRIGUING PHENOMENON ON NEAR EARTH ASTEROID BENNU

Scientists believe 4.5 billion years old primitive asteroid Bennu has secrets which will explain several things about our early solar system. Bennu with diameter of 492 meters is known to have 1 in 1000 chances of hitting Earth late in the 22nd century.

It is rich in amino acids and organic molecules considered as building blocks of life and may provide clues to the origin of life on Earth. The Origins, Spectral Interpretation, Resource Identification, Security Regolith Explorer (OSIRIS-REx) is a Lockheed Martin designed and built satellite orbiting Bennu and managed by NASA's Goddard Space Flight Centre with Science mission led by Arizona University. It is a unique long drawn programme launched on Sept.8,2016. Among other notable achievements so far, pick and fly sample collection by July 2020, Asteroid departure manoeuvre by March 2021 and finally sample return by Sept.24,2023 are expected to take place with military precision.

Bennu orbits around Sun at 61300 mph. Catching up with the asteroid and sample collection from the surface by the OSiRis-REx in time and space is the real challenge. The space craft also is expected to bring incredible information about the asteroid using x-Ray spectrometer, IR spectrometer, visible light cameras, LIDAR scanner etc. These instruments have to survive from the dust and rocks which are spewed by Bennu to create its own miniature moons. Scientists believe Bennu is a relic from the age of planet formation in the early solar system, these surface samples may reveal clues as to formation Earth, it's water, origin of life etc.

WHAT IS ARMSTRONG LIMIT?

This corresponds to height of altitude of 19000 m at which the atmospheric pressure (6.3 KPa) is so low that water boils at human body temperature (37^{o}C). We know boiling point of water is 100^{o}C at sea level or 71^{o}C on Mt Everest. The Armstrong pressure limit makes body saliva, blood, tears boil making human survival difficult without wearing special pressurized suits for Astronauts.

NEW SPACE INDIA LIMITED (NSIL)

NSIL is a central PSU of Govt. of India. It was established on March 6, 2019 under the administrative control of Dept of Space. The main objective of NSIL is to scale up industry participation in Indian Space Programme.NSIL has been incorporated to carry out the following roles and functions:

(i) Small Satellite technology transfer to industry, wherein NSIL will obtain license from DOS/ISRO and sub-license it to Industries;

(ii) Manufacture of Small Satellite Launch Vehicle (SSLV) in collaboration with Private Sector;

(iii) Productionisation of Polar Satellite Launch Vehicle (PSLV) through Indian Industry;

(iv) Productionisation and marketing of Space based products and services, including launch and application;

(v) Transfer of technology developed by ISRO Centres and constituent units of DOS;

(vi) Marketing spin-off technologies and products/services, both in India and abroad;

(vii) any other subject which Government of India deems fit. NSIL was set up to meet the ever-increasing demands of Indian space programme and to commercially exploit the emerging global space market.

The emergence of NSIL would spur the growth of Indian industries in the space sector and enable Indian industries to scale up manufacturing and production base.

LOCKDOWN AFFECTS TRAINING PROGRAM OF INDIAN PILOTS

Gagarin Cosmonaut Training Centre where 4 Indian pilots are being trained is under lockdown till April end. The pilots are staying safe.

ABOUT THIS NEWSLETTER

This quarterly Newsletter 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 endeavour to keep this newsletter fresh and engaging with well researched content. Interested persons can contribute by way of small articles. Any suggestion(s) for improvement of this newsletter shall be highly appreciated.

- Editor

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