RECENT INNOVATIONS IN SPACE TECHNOLOGY

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INTRODUCTION

India has recently witnessed many significant achievements in the field of Space Technology which caught the attention of the country as well as the outside world. Research and Development (R&D) activities in Department of Space and Indian Space Research Organisation (ISRO) have yielded many innovative technologies and products, which have been flight tested and proved their usefulness. R&D in semi-cryogenic propulsion engine, air breathing propulsion and re-usable launch vehicle technology are pursued in an effort towards reducing the cost of access to space. Development of critical technologies for undertaking human spaceflight has also made additional progress\(^1\).

The Government have drawn-up a long-term plan ‘Space Vision 2025’ for Space Research Programme identifying the goals, Programme Directions and technology requirements upto 2025. The Programme encompasses development of advanced launch vehicle systems including critical technologies for re-usable launch vehicles and Human Space Flight Programme; developing capabilities in Space communications towards meeting the developmental needs in the areas of education and literacy, health-care, rural development and disaster management support; Introduction of Satellite Navigation based positioning services, Augmenting earth observation systems with enhanced imaging capabilities for natural resource management applications; and undertake front ranking research in the areas of Space science, Astronomy and Planetary exploration\(^2\).

\(^1\) India, Department of Space, Inputs received vide letter dated 30 June 2016.
\(^2\) Rajya Sabha Unstarred Question No. 3794 dated 29.04.2010.
Some of the important innovations in Space Technology in recent times are given below:\(^3\):

**Space Transportation Systems:**

- **High Thrust Cryogenic Engine:**
  Indian Space Research Organisation (ISRO) has developed a fully indigenous high thrust cryogenic engine, one of the most powerful engines of upper stages in the world. The engine works on “Gas Generator Cycle” which allows flexibility in terms of independent development of each sub-system before the integrated engine test, thereby minimizing the uncertainty in final development phase and reducing development time.

- **Lithium ion Batteries for space applications:**
  A new generation batteries, Lithium ion batteries with 50Ah and 100Ah capacity were realized and flight tested in Reusable Launch Vehicle-Technology Demonstrator (RLV-TD). Besides offering advantage in volume and mass over other systems, these batteries have application in the automobile industry.

- **Mobile Multi-object Tracking Radar (MOTR):**
  ISRO has devised a mobile version of the indigenous Multi-Object Tracking Radar (MOTR) located at Sriharikota, Andhra Pradesh, with capability to track targets at a distance of about 100km. It is fully self sufficient with onboard generator and Very Small Aperture Terminals(VSAT) connectivity, which can be installed at any location and operationalised within 4 hours. This system is developed using state-of-the-art technology to suit the surveillance requirements.

- **Search and Rescue Beacon:**
  Search and Rescue Beacon, an affordable and technically advanced electronic device that helps to rescue people in distress through satellite communication, is another innovation from ISRO. This beacon can be used in sea, on difficult terrains on the land and in air. This is being used by the Indian fisherman community.

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\(^3\) *Op.cit.*, Department of Space, 30 June 2016.
- **Silica Aerogels:**
  Silica Aerogels, one of the world’s lightest materials with super-insulating property is a recent innovation at ISRO. It has applications in rovers, spacesuits & insulation for cryogenic tanks, jackets to use in extremely cold climates, foot-in-soles, translucent windows to retard heat, as a filler in paint and cement, oil spill adsorbent, etc.

- **CASPOL:**
  CASPOL is a flame retardant, waterproofing and thermal control coating material that ISRO has prepared recently. It is a room temperature curable, water-based formulation having low solar absorptance and self-extinguishing properties. In addition to space applications, this material has good applicability to ground applications for flame and waterproofing requirements. It confers excellent flame retardant, waterproofing and thermal control properties to substrates ranging from masonry surfaces, textiles, paper, thatched leaves, wood, etc. to advanced materials like polyurethane and phenolic based thermal insulation foam pads.

- **Pressure Transducers:**
  ISRO has developed a novel custom-designed internal Diaphragm Pressure Transducer for space application, which also has wide industrial and commercial application. These transducers have high accuracy output, rugged construction and hermetic sealing. Additionally, any damage to the sensing element will be contained within the sensor thus avoiding any sort of catastrophic damage in the system.

- **Microprocessor for space applications:**
  ISRO’s 16-bit microprocessor with support for floating point operations along with in-house Ada compiler and software tool set is another innovation for space application. The processor design was recently fabricated within the country at Semi-conductor Laboratory (SCL), Chandigarh.
• **Acousto-ultrasonic test system:**
  Acousto-ultrasonic test system is a patented non-destructive test equipment developed by ISRO for testing the structural integrity of low density, low strength and porous non-metallic materials like silica tiles, cryofoam, ablatives, etc. The system works on acoustic and ultrasonic range of frequencies and does not require the use of harmful liquid couplant that is usually required in conventional equipment.

**Space Science:**

• **Innovations for Mars Orbiter Mission:**
  Mars Orbiter Mission has demonstrated our technological capabilities in accomplishing inter-planetary mission. Several indigenous innovative methods were devised and used in this mission. A few of these innovations are (a) Deep space communication, navigation, autonomous mission planning and management; (b) Design and development of autonomous spacecraft to survive earth-bound manoeuvres, cruise phase, Mars orbit insertion and capture, and on-orbit phase around Mars for a design life of 6 months, while taking care of communication blackouts; (c) Restart of 440N engine after 300 days of dormancy and precise firing in close loop along with the thrusters; (d) Improvements in Orbit determination software, etc.

• **Innovations for Astrosat Missions:**
  ASTROSAT Mission, a multi-wavelength astronomical observatory, is a source for several innovations both in the payload as well as on the ground. These innovations include (a) Indigenous realisation of 1.8 arcsec resolution for Far Ultraviolet (UV) and Near UV mirrors and coatings for Ultraviolet Imaging Telescope (UVIT); (b) Development of indigenous thin foil X-ray optics (320 foils) in Soft X-ray Telescope (SXT); (c) Designing and realising a sputtering system for Gold to glass, epoxy spray system (d) Development, testing and calibration of totally indigenous high pressure gas filled detectors and associated electronics of Large Area X-ray Proportional Counter (LAXPC) instrument; (e) Development, testing and
calibration of totally indigenous 1-D position sensitive gas proportional counters and associated electronics for Scanning Sky Monitor (SSM); (f) Qualifying commercially available (used for medical imaging) Cadmium-Zinc-Telluride (CZT) detectors for space astronomy. Development, testing and calibration of indigenous CZT payload and electronics.

Satellite Communication:

- **S-Band Unfurlable Antenna:**
  ISRO has designed, developed and deployed in space the S-Band Unfurlable Antenna of 6 m diameter. This is the largest satellite antenna realised by ISRO. This antenna is utilised for five spot beams over the Indian main land. The spot beams exploit the frequency reuse scheme to increase frequency spectrum utilisation efficiency. The other advanced feature of the satellite is the 70 V bus, which is flying first time in an Indian communication satellite.

- **Miniaturisation:**
  Miniaturisation and indigenisation of subsystems like Monolithic Microwave Integrated Circuit (MMIC) based C and Ku-band receivers, S-band Low Noise Amplifiers, 15W Solid State Power Amplified in S-band are some of the other innovations that were developed at ISRO.

- **Satellite Navigation:**
  ISRO has established a satellite based regional Navigation Indian Constellation (NavIC), with 7 satellites positioned in space with a unique configuration, to provide position, navigation and timing services. As part of the development process, innovations like high power L&S band subsystems, shared aperture dual helix array in L&S band, etc. were realised.

- **GAGAN⁴:**

  GPS Aided Geo Augumented Navigation (GAGAN), a joint initiative of ISRO and Airports Authority of India (AAI), is a satellite based Augmentation system (SBAS) for

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⁴ Achievements: Department of Space, 2 Years of NDA Government, Press Information Bureau, May 2016.
Indian airspace that enhances the integrity and accuracy of GPS services. Three GSAT series of satellites – GSAT-8, GSAT-10 and GSAT-15 – already in orbit, are carrying GAGAN transponders. The system was certified for en-route air operations in 2013 and for precision approach during 2015.

**Bhuvan Geoportal**:

Bhuvan Geoportal (bhuvan.nrsc.gov.in) is providing seamless high resolution remote sensing data (1m to 2.5m) for visualisation, terrain data and thematic layer overlays of Indian region along with a host of services in the areas of disaster, weather, land and ocean for general public. It has about 51,000 registered users and has served more than 2.8 lakh downloads. On 12 August 2015, the Union Minister Dr. Jitendra Singh released New services of Bhuvan. The new application services include 1 m images of over 300 Cities of the country and a host of visualisation applications for common man.

**CONCLUSION**

Indian space programme has made significant progress in its quest towards mastering critical technologies and witnessed significant milestones in space exploration. Necessary infrastructure for casting large boosters, liquid propellant engines, heavy cryogenic boosters for advanced heavier launchers and missions in the area of remote sensing, communications and navigational satellites as well as space science have been established.

The innovation and expansion of space applications programmes like tele-education and disaster management support and outreach through Direct-To-Home television, reiterates the increasing role played by the Indian space systems in providing direct benefits to the society. Thus, Indian Space Programme continues to pursue successful goals on all fronts in meeting its objective.

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5 *Ibid, Achievements: Department of Space, May 2016.*

6 *India, Department of Space, Annual Report 2015-16.*
REFERENCES:

1. India, Department of Space, 30 June 2016.

2. India, Department of Space, Annual Report 2015-16.
