Event Flow

Round 1 - The participants are expected to submit an abstract, which includes at least the following parameters-

- Description of the chosen problem statement
- Proposed solution and its need over the existing technology
- Architecture diagram
- Parameters used to evaluate current technology
- Tech Stack and basic outline of the working principle
- Feasibility of the solution

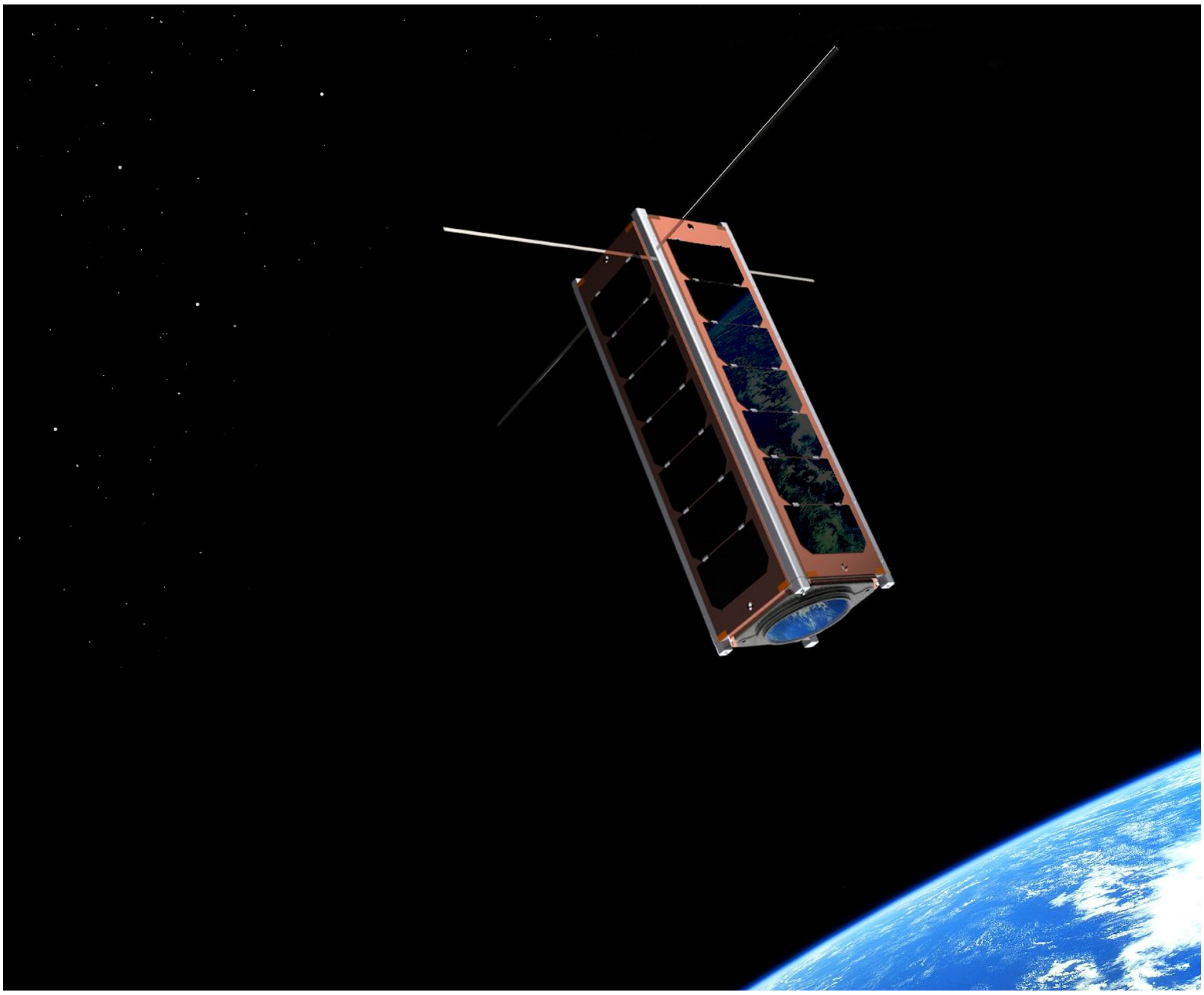
Round 2 - of the hackathon will be conducted in VIT, Vellore, where the selected students would be expected to develop a prototype/model, and/or conduct analysis using the specified constraints, and as required for their proposed solution. The teams would be evaluated based on their technical innovation, ingenuity, and feasibility.

Round 3 - Selected teams from Round 2 will be given a chance to present their work in front of the esteemed guests and judges, and will be evaluated by the same.

Problem Statements

1) Design a cooling system to keep the temperature fluctuations in the CubeSat or a NanoSat to a minimum

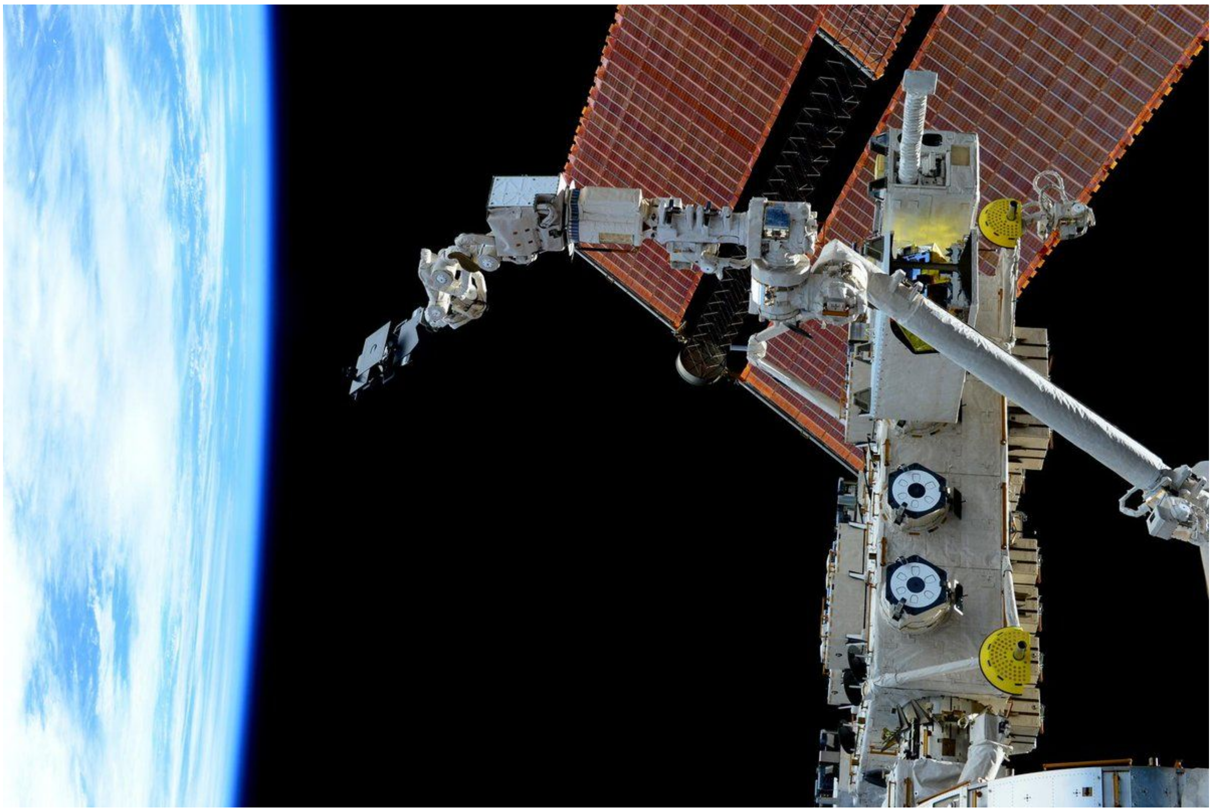
One of the biggest problems that various satellites face is the change in temperature of the on-board components when they travel from the dark side of the planet to the one facing the sun. This causes a major fluctuation in temperatures. The mechanism that generates the thermal force that acts on the satellites is very simple. Due to heat absorption, transfer and emission on one side, the satellite surface presents an asymmetric temperature distribution and causes a change in momentum which can manifest in spinning and non-spinning satellites in different manners. This problem can cause orbital decays in satellites which, if not corrected will interfere with its primary objective. The cooling system design must take into consideration the size of the CubeSat or a NanoSat. It must reduce these temperature fluctuations and keep them to a minimum. Also, it must utilize minimal power and have high efficiency along with a description of methods of heat transfer i.e. conduction, convection or radiation.



2) Obstacle avoidance in space robotics

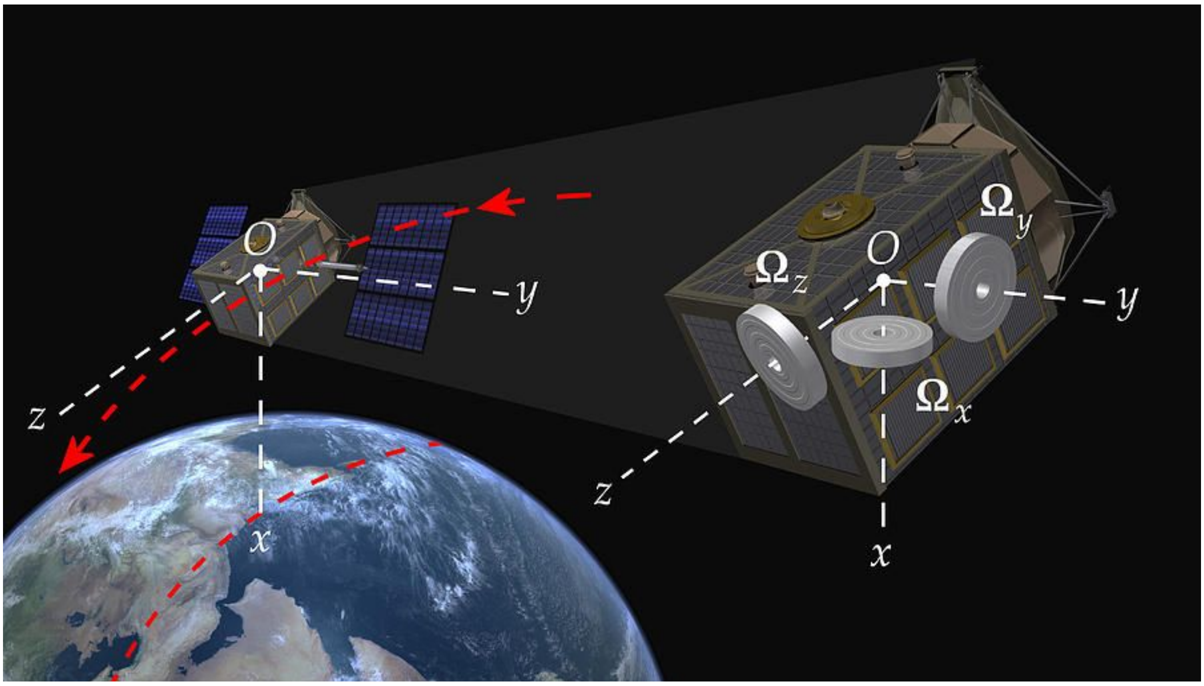
Manipulators can be utilized for various purposes during space missions, e.g. Canadarm2 manipulator mounted on the International Space Station assists in station construction and maintenance. Up to now, with only a few exceptions, manipulators in space have always been controlled by astronauts or by operators on the ground. It is envisaged that in the near future space robots, i.e. small and highly autonomous satellites equipped with manipulators, will also be used for on-orbit assembly of large structures, such as large space telescopes and solar-powered satellites. Using robots instead of astronauts for assembly work will minimize risk for humans and will significantly reduce mission costs.

The mission described above poses new challenges and requires advancements in the field of space robotics. The major problem that must be addressed here is obstacle avoidance. Design a space manipulator mounted on a small satellite and simulate a collision-free trajectory for the same using any robotic simulation software such as WeBots, Gazebo, V-REP, etc.



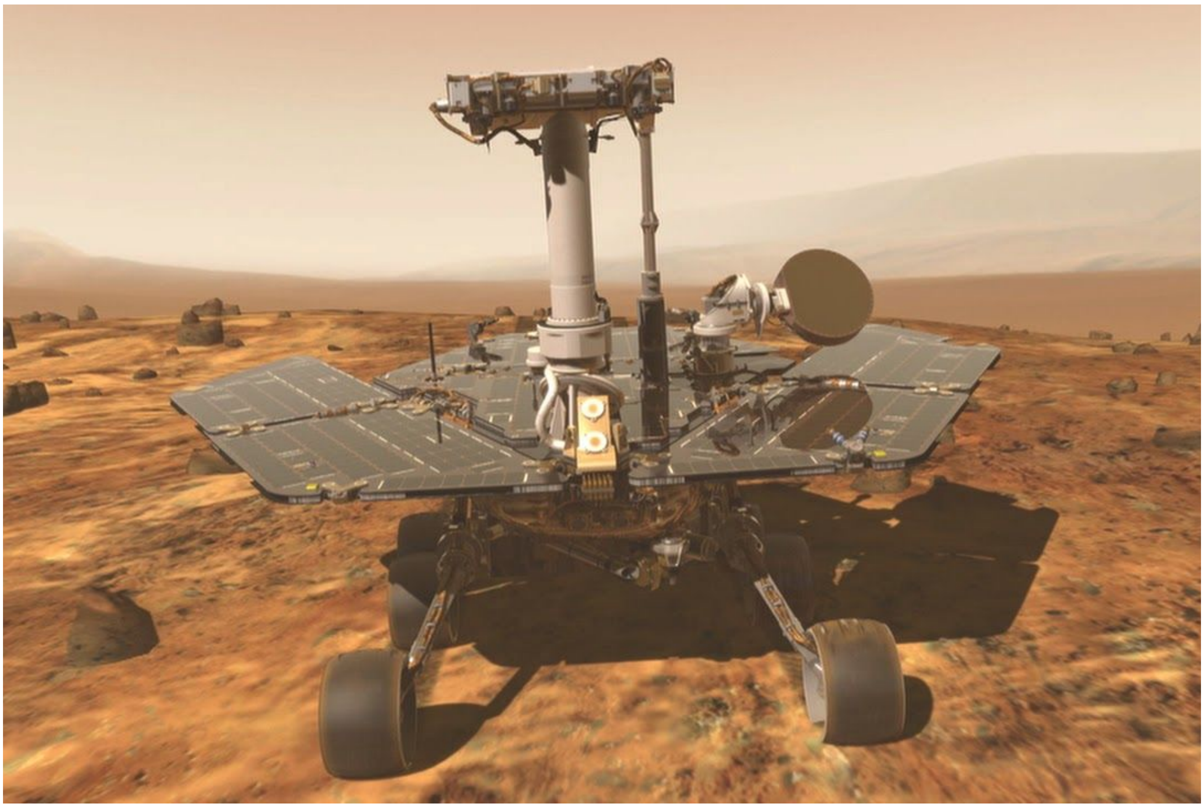
3) Attitude control system for nanosatellites

Among the various challenges involved in the development of CubeSats, lies the attitude determination and control of the satellite. The importance of a properly functioning *Attitude Determination and Control System (ADCS)* on any satellite is vital to the satisfaction of its mission objectives. Due to this importance, three-axis attitude control simulators are commonly used to test and validate spacecraft attitude control systems before the flight. However, these systems are generally too large to successfully test the attitude control systems onboard CubeSat class satellites. Due to their low cost and rapid development time, CubeSats have become an increasingly popular platform used in the study of space science and engineering research. The scope of this challenge is to create an attitude control system, integrated into a 5 cm side cube structure, integrating magnetometers, magnetorquer, reaction wheels, control and interface to the spacecraft. The result is an attitude control system, capable of maneuvering the satellite around three axes, both with magnetic actuators and reaction wheels, with integrated sensors, a serial interface with the spacecraft, and low power consumption.



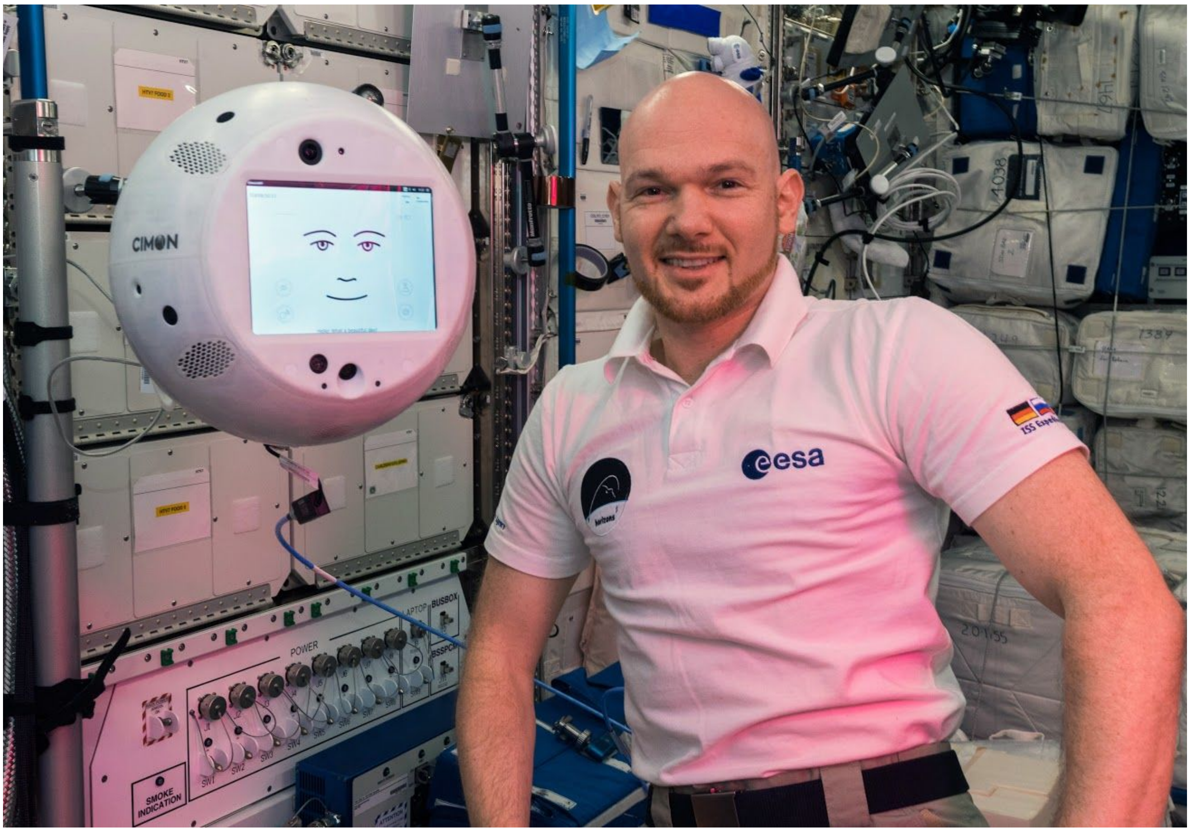
4) Autonomous solar panel cleaning/preventive system

Due to the planetary dust storm on Mars, *Opportunity rover* ceased communications in 2018. It was hoped it would reboot once the weather cleared, but it did not, suggesting either a catastrophic failure or that a layer of dust had covered its solar panels. The rover had no mechanism which could clean up or prevent the accumulation of dust on the solar panels. Create an autonomous cleaning/preventive system for the solar panels which can save future rovers from dust layers thicker than 5 cm.



5) Astronaut assistant (Mech, EEE)

NASA recently sent an astronaut assistant called 'CIMON', a mobile and autonomous assistance system designed to aid astronauts with their everyday tasks on the ISS (International Space Station). This was the first form of AI on an ISS mission. CIMON is able to see, hear, understand, speak – and fly inside the ISS. The objective of this problem is to design a model of a robot, for ISS, with all the electronics embedded within, should be able to maneuver within zero gravity, control the living conditions within ISS, and amenities onboard.



6) Astronaut assistant (CSE)

With reference to the assistant described in the previous statement, design the framework and use a voice-and-text-based assistant which can help the astronauts in their daily routine and missions and is able to control the amenities onboard the Space Station.

7) Data compression using machine learning

Machine learning has found its way into data compression. Algorithms to compress data losslessly using machine learning have started being developed to speed up the process of compression and make it scalable for high dimensional data. All the equipment sent to deep space gathers tremendous amounts of high dimensional data. This data needs to be transmitted over millions of kilometers with small, time-windows of transmission and moreover the transmission rate is still pretty low. Develop a machine learning algorithm that can compress this data using fewer resources. You can get a dataset from NASA's website and compress it.

https://data.nasa.gov/

8) Wearable devices for astronauts

Space and spaceflight are both environments where doing even the simplest of tasks is painstaking and has many detrimental effects on human health. EVAs are one of the riskiest tasks that all astronauts have to perform in space. To participate in health experiments, astronauts must use several medical devices that are often bulky and invasive. Using them is disruptive and time-consuming and wastes tremendous amounts of valuable time in spaceflights. Along with that, they do not have a map or any other guidance system during the EVA either. Design a helmet with a visor that has built-in heads up display functionality, that acts as an interfacing biomonitoring device, keeping track of astronaut's physical health, environmental conditions (such as carbon dioxide pockets that could pose health risks to the crew members), as well as helps in maneuvering and aiding the astronaut during the mission.

9) A self-degrading/destructing system for satellites to reduce/prevent space debris

Satellites are built to endure decades in the most inhospitable conditions in the known universe. Paradoxically, scientists are now trying to figure out how to design them so that towards the end of their life they do not add to the ever-increasing amounts of space debris. Can you design a satellite with in-built features or a mechanism that, at the end of its functional lifetime (an average of 8 years) undergoes a phenomenon that prevents it from becoming debris?

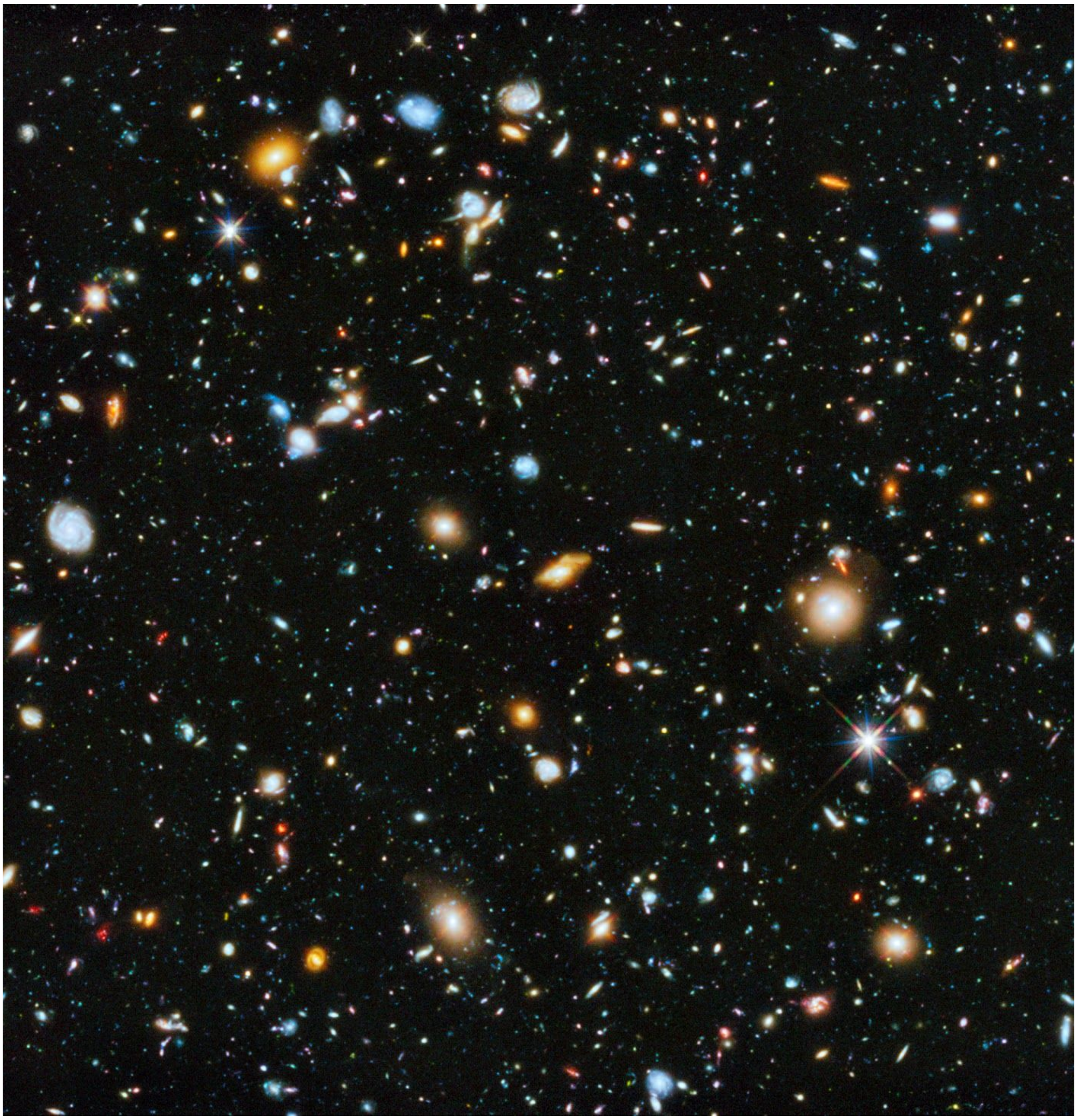
10) Indoor navigation control

The objective of this challenge is to develop an innovative idea, solution, application, technology and or service that helps to improve indoor navigation. Global Navigation Satellite Systems are the unique source for positioning, navigation, and timing but due to a very weak electromagnetic signal that travels ~23,000km from a satellite and due to the frequencies used, its penetration inside walls is very limited. Moreover, for precise measurements and position computation, a direct line of sight between the transmitting antenna of satellite and receiving antenna of receiver must be met. Any kind of signal reflection is undesirable. For precise positioning, navigation and timing inside objects (where an authentic GNSS signal is shielded) alternative technical solutions must be placed.

The competitor shall be creative in developing technological solutions that complement standard GNSS based PNT for indoor navigation. New technical and or physical concepts shall be proposed, combined with any kind of signal of opportunities, combination and fusion with additional sources (e.g. inertial systems), etc. shall be utilized.

11) Astrophotography

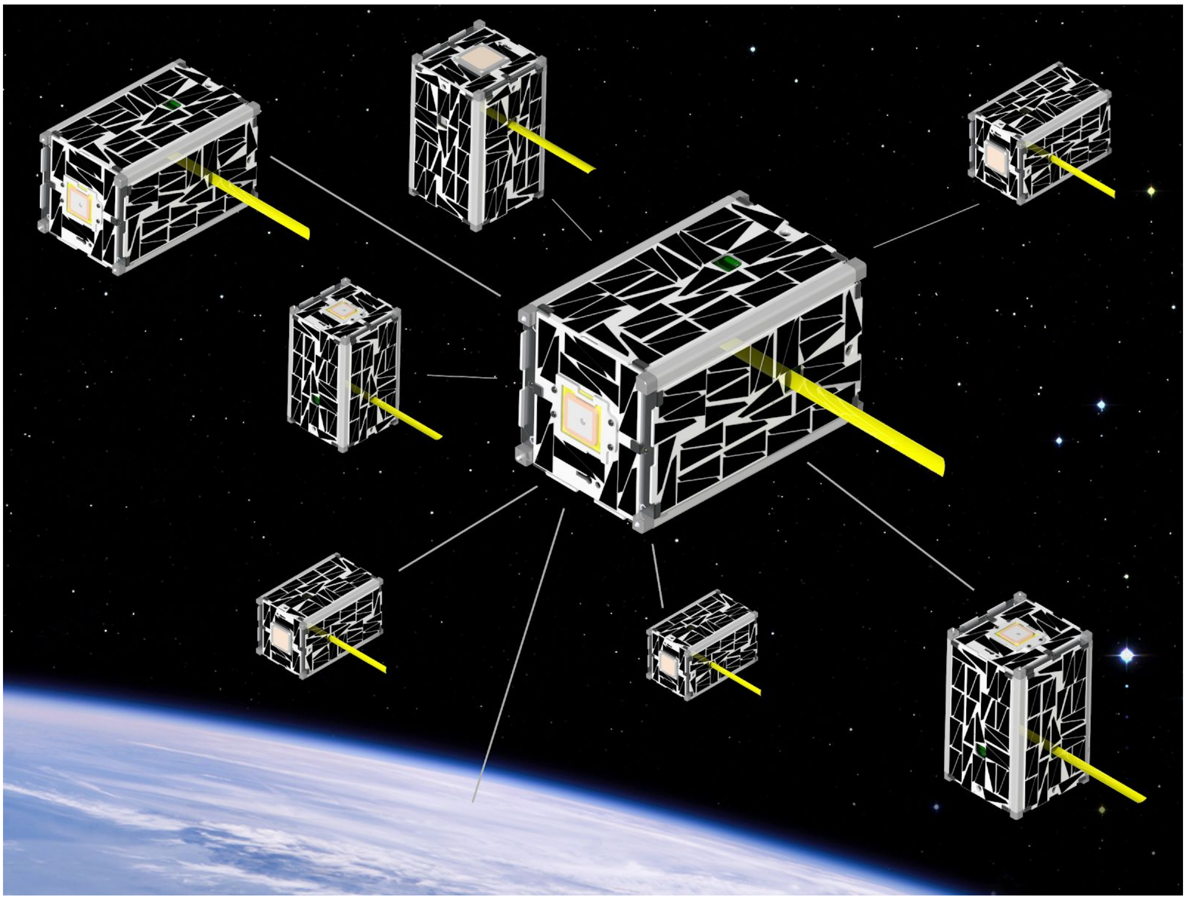
Taking pictures of the night sky has so far been the domain of large cameras, such as DSLRs, which are able to achieve excellent image quality, provided photographers are willing to put up with bulky expensive equipment and sometimes tricky postprocessing. With the help of AI, develop a camera and tracker system with a cheap camera that can shoot, and process images of astronomical bodies comparable to expensive cameras. Conventional tracking mechanisms take into account only the relative motion of the celestial bodies with respect to our viewpoint. Your system must be smart in order to detect a specific recognizable celestial body in the frame and track it (keep it centered within the camera frame) during shooting to increase the effective exposure time and bring out its details.



12) CubeSat swarm to build a satellite constellation

Increasing demand for small satellite constellations requires efficient communication architectures in science missions such as gravity mapping, tracking forest fires, finding water resources or detecting vector diseases on Earth. There is an emerging trend towards using CubeSats to perform educational, scientific and observation missions thanks to their low cost and easy production opportunities.

The purpose of this challenge is to expand from one small satellite to a swarm of small satellites working together. This has the potential to multiply the impact and effectiveness of a single CubeSat while taking advantage of its production affordability. The swarm must be able to establish reliable communication between the nodes and perform simple tasks or align in simple configurations with respect to each other synchronously.

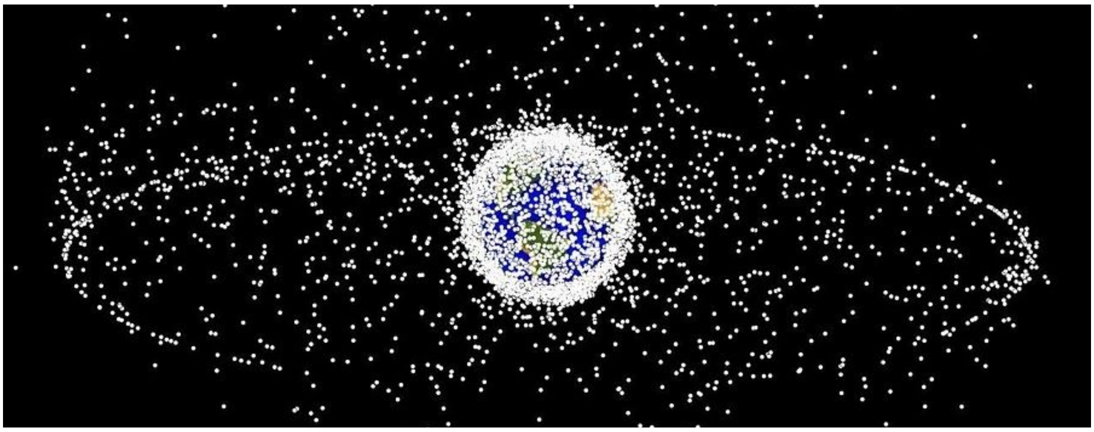


13) Low-cost CubeSat with a modular design

The major objective is to design a CubeSat frame optimized for rapid manufacturing. By using the benefits of design principles, mass distributions and materials can be redesigned to minimize weight and component count on the CubeSat can be reduced to improve production, which therefore results in a reduced cost. With the newly introduced 3D printing capability of space stations like the ISS, your design must have modular units or interchangeable parts that can be printed and replaced for easy servicing from space. This will reduce the need for sending more and more CubeSats into space every year as well as increase the durability and average lifetime of a CubeSat.

14) Space debris tracking system

The rising population of space debris increases the potential danger to all space vehicles. More than 500,000 pieces of debris are tracked as they orbit the Earth. Use blockchain to create a decentralized system for all space agencies worldwide to track and update the system for space debris.



15) Rover wheels-suspension system design for traversing extreme terrain

Lunar and Martian terrain is rocky, with canyons, volcanoes, dry lake beds and craters all over them. It even has ice on the poles. Mobile robots such as rovers face huge challenges while traversing these terrains especially since servicing the contact elements is virtually impossible. Due to the sharp and pointed rocks on the surface, the Curiosity rover was seen to have dents in its wheels just after a year in service. While obstacle avoidance is key in rover traversal, its design must be tolerant of unexpected impacts and unavoidable obstacles. Your task is to come up with a novel wheel and suspension system design that can safely traverse extra-terrestrial terrain without sustaining damage, withstand high amounts of mechanical stress and load while also providing the required tractive force to traverse smoothly over uneven terrain.

16) Rogue Planets: Open Innovation

Space science encompasses all of the scientific disciplines that involve space exploration and study natural phenomena and physical bodies occurring in outer space. It includes Rocket science, Space exploration, Satellite design, Observational Astronomy and more.

You are free to choose any problem statement relating to Space Sciences and solve it using any recent technology like the ones mentioned below.

- Augmented Reality/Virtual Reality
- Blockchain
- Big Data
- Deep Learning
- IoT - Internet of Things
- AI, Machine Learning & Robotics
- Nanotechnology (Materials)
- Computational Fluid Dynamics
- ET Life Detection (Biotech)