Parikshit Student Satellite Team 2U CubeSat Mission: Thermal Imaging and Electrodynamic Tether

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***Abstract*—This work presents the Parikshit Student Satellite Team's 2U CubeSat mission, carrying a high-resolution thermal imaging camera and an experimental electrodynamic tether for propellantless deorbiting in a ∼500 km polar Sun-synchronous orbit. The paper details the satellite architecture, in-house subsystems (ADCS, COMMS, ODHS, EPS, STMS), and an auxiliary Environmental CanSat for atmospheric profiling. Innovations include tether-based deorbit technology and onboard thermal imaging. Trajectory simulations, subsystem performance, and preliminary results demonstrate mission readiness and compliance with space debris mitigation guidelines.**

I. Introduction

The Parikshit Student Satellite Team, established in 2013 at Manipal Institute of Technology, India, is developing a 2U CubeSat (10×10×22.7 cm, 2.3 kg) for Earth observation and propellantless deorbiting. Primary objectives include high-resolution thermal imaging of urban heat islands and ocean surface temperatures using a FLIR microbolometer (7.5–13.5 μm) and testing an electrodynamic tether for end-of-life disposal. A complementary Environmental CanSat gathers vertical atmospheric profiles of pressure, temperature, humidity, and particulate matter during descent, integrating space technology with environmental science.

II. Mission Overview

A. Thermal Imaging CubeSat with Tether

The CubeSat houses an uncooled thermal camera and a Saber Astronautics DragEN electrodynamic tether. Post-mission, the 1 km bare-tether deploys, generating Lorentz forces that accelerate orbital decay, targeting deorbit within a few years to comply with debris guidelines. Figure 1 shows the internal layout

B. Environmental CanSat

Constructed for the ASI CanSat competition, the soda-can-sized probe carries sensors for atmospheric pressure, temperature, humidity, and PM2.5. It records and stores vertical environmental data during parachute descent for later analysis (see Fig. 3).

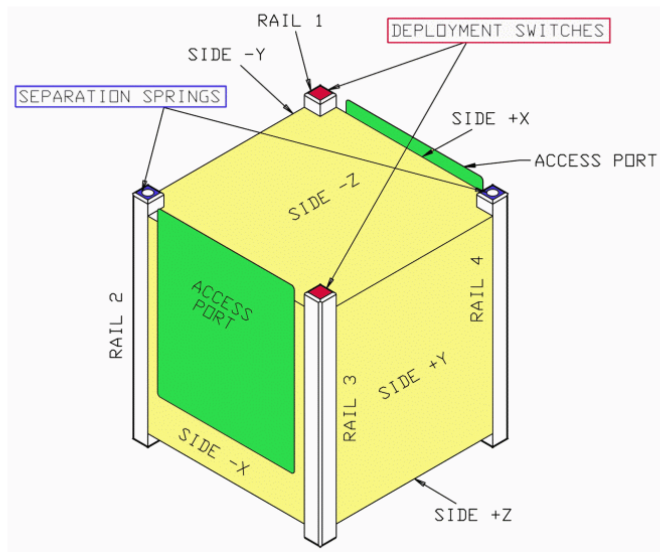

Fig. 1: Internal structure of the 2U CubeSat.

III. Subsystems

A. Attitude Determination and Control (ADCS)

The ADCS integrates three reaction wheels, three magnetorquers, MEMS gyros, sun sensors, and a magnetometer. A Kalman filter and PID algorithms maintain pointing accuracy below 0.1° for stable imaging.

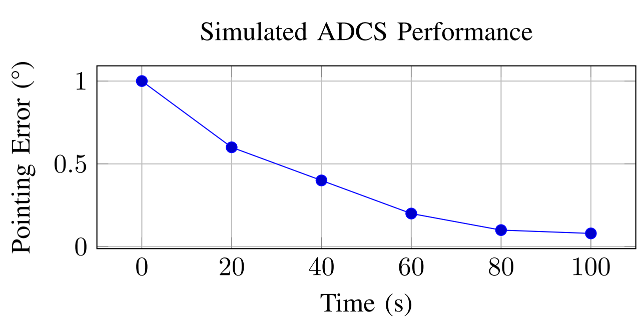

Fig. 2: Simulated ADCS pointing error over time.

B. Communications (COMMS)

The COMMS subsystem uses UHF (435.775 MHz) telemetry at 2.4 kbps and VHF beacon at 145.890 MHz. Custom RF boards and deployable antennas enable two-way links with ground stations, supporting telemetry, telecommands, and payload downlink.

C. Onboard Data Handling (ODHS)

An ARM Cortex-M4 microcontroller running FreeRTOS orchestrates data acquisition, CRC error checking, compression, storage (2 GB NAND), and command execution from ground.

D. Electronics and Power (EPS)

Face-mounted solar panels (6 W), a 20 Wh Li-ion battery with MPPT regulators, and DC–DC converters supply stable 3.3 V, 5 V, and 12 V buses, managing power for all subsystems.

E. Structures, Thermal, and Mechanisms (STMS)

The aluminum chassis provides structural support, thermal conduction paths, and mount points. Multilayer insulation and internal heaters maintain instrument temperatures. The tether deployer uses a spring-lock mechanism for reliable release.

IV. Environmental CanSat Profiling

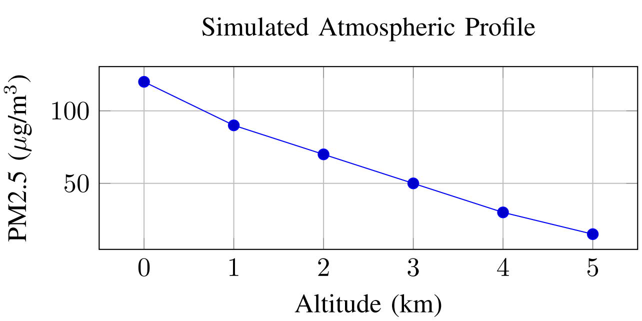

Fig. 3: Simulated vertical profile of particulate pollution.

V. Trajectory and Orbit Decay

Atmospheric drag alone yields slow decay at 500 km. With a 1 km tether, Lorentz drag accelerates decay; Table I summarizes sample results.

TABLE I: Simulated orbit decay post tether deployment

Days	Altitude without tether (km)	Altitude with tether (km)
0	500	500
365	499	400
730	498	300
1095	497	200
1460	495	100

VI. Preliminary Results

Subsystem simulations meet requirements: ADCS pointing ¡0.1°, COMMS link verified at 2.4 kbps, EPS recharge time 45 min. CanSat profiles align with atmospheric models.

VII. Conclusion and Future Work

The Parikshit mission demonstrates comprehensive student-led engineering: thermal imaging, EDT deorbit, and environmental profiling. Next steps include hardware-in-the-loop testing, thermal-vacuum qualification, and a planned ISRO launch in 2026. Public release of CanSat data will enhance environmental research.

References

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